NUREG-0586

Final Generic Environmental Impact Statement
on decommissioning of nuclear facilities

U.S. Nuclear Regulatory Commission

Office of Nuclear Regulatory Research

August 1988

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FOREWORD
BY
NUCLEAR REGULATORY COMMISSION STAFF

The NRC staff is in the process of reappraising its regulatory position relative to the decommissioning of nuclear facilities. The initial part of this activity consisted of obtaining the information base to support any subsequent regulatory changes. Highly detailed studies were completed, through technical assistance contracts of the technology, safety and costs of decommissioning various nuclear facilities. (These studies are referenced in this document). These studies were, in turn, utilized along with other information, to prepare a Draft Generic Environmental Statement on Decommissioning Nuclear Facilities, draft GEIS, NUREG-0586, January 1981. On February 11, 1985, the Commission published a notice of proposed rulemaking on decommissioning criteria for nuclear facilities (50 FR 5600).

This Final Generic Environmental Impact Statement on Decommissioning Nuclear Facilities is being published based on public comment on the draft GEIS and on the proposed rule as well as on updated information in the technical information base. This statement is required because the regulatory changes that might result from the reevaluation of decommissioning policy may be a major NRC action affecting the quality of the human environment.

The information provided in this Statement, including any comments, will be included in the record for consideration by the Commission in establishing criteria and new standards for decommissioning.

ABSTRACT

This final generic environmental impact statement was prepared as part of the requirement for considering changes in regulations on decommissioning of commercial nuclear facilities. Consideration is given to the decommissioning of pressurized water reactors, boiling water reactors, research and test reactors, fuel reprocessing plants (FRPs) (currently, use of FRPs in the commercial sector is not being considered), small mixed oxide fuel fabrication plants, uranium hexafluoride conversion plants, uranium fuel fabrication plants, independent spent fuel storage installations, and non-fuel-cycle facilities for handling byproduct, source and special nuclear materials. Excluded here from consideration for regulation change, are decommissioning of low-level waste burial facilities, high-level waste repositories, and uranium mill and mill tailings piles, which are covered in separate rulemaking activities, and decommissioning of uranium mines which are not under NRC jurisdiction.

Decommissioning has many positive environmental impacts such as the return of possibly valuable land to the public domain and the elimination of potential problems associated with increased numbers of radioactively contaminated facilities with a minimal use of resources. Major adverse impacts are shown to be routine occupational radiation doses and the commitment of nominally small amounts of land to radioactive waste disposal. Other impacts, including public radiation doses, are minor. Mitigation of potential health, safety, and environmental impacts requires more specific and detailed regulatory guidance than is currently available. Recommendations are made as to regulatory decommissioning particulars including such aspects as decommissioning alternatives, appropriate preliminary planning requirements at the time of commissioning, final planning requirements prior to termination of facility operations, assurance of funding for decommissioning, environmental review requirements,

OVERVIEW

At the end of a commercial nuclear facility's useful life, termination of its license by the Nuclear Regulatory Commission (NRC) is a desired objective. Such termination requires that the facility be decommissioned. Decommissioning means the removal of a nuclear facility safely from service and reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. It is the objective of NRC regulatory activities in protecting public health and safety to provide to the applicant or licensee appropriate regulations and guidance to accomplish nuclear facility decommissioning.

Although decommissioning is not an imminent health and safety problem, the nuclear industry is maturing. Nuclear facilities have been operating for a number of years, and the number and complexity of facilities that will require decommissioning is expected to increase in the near future. Accordingly, the NRC is reevaluating its regulatory requirements concerning decommissioning. This final generic environmental impact statement is part of this reevaluation.

PAST ACTIVITIES

In support of this reevaluation, a data base on the technology, safety, and cost of decommissioning various nuclear facilities and on other matters related to decommissioning, including financial assurance, is being completed for the NRC by Battelle Pacific Northwest Laboratory (PNL), by Oak Ridge National Laboratory and by other contractors. Based on this data base and on input from other State and Federal government agencies and the public, NRC has modified and amplified its policy considerations and data base requirements in a manner responsive to comments received. Another area addressed is the generic applicability of the data base for specific facility types. This has been addressed through expansion of the PNL facility reports to include sensitivity analyses for a variety of parameters potentially affecting safety and cost considerations. A draft generic environmental impact statement was issued in January, 1981 and comments received have been considered in the development of this final statement. On February 11, 1985, the NRC published a notice of proposed rulemaking on Decommissioning Criteria for Nuclear Facilities (50 FR 5600). The proposed amendments covered a number of topics related to decommissioning that would be applicable to 10 CFR Parts 30, 40, 50, 51, 70, and 72 applicants and licensees. These topics included decommissioning alternatives, planning, assurance of funds for decommissioning, environmental review requirements, and residual radioactivity.

SCOPE OF THE EIS

Regulatory changes are being considered for both fuel cycle and non-fuel-cycle nuclear facilities. The fuel cycle facilities are pressurized (PWR) and boiling water (BWR) light water reactors (LWRs) for both single and multiple reactor sites, research and test reactors, fuel reprocessing plants (FRPs) (currently, use of FRPs in the commercial sector is not being considered), small mixed oxide (MOX) fuel fabrication plants, uranium fuel fabrication plants (U-fab), uranium hexafluoride conversion plants (UF_6), and independent spent fuel storage installations (ISFSI). Under non-fuel-cycle facilities, consideration is given to major types such as radiopharmaceutical or industrial radioisotope supplier facilities, various research radioisotope laboratories, and rare metal ore processing plants where uranium and thorium are concentrated in the tailings.

This EIS addresses only those issues involved in the activities carried out at the end of a nuclear facility's useful life which permit the facility to be removed safely from service and the property to be released for unrestricted use. It does not address the considerations involved in extending the life of a nuclear facility. If a licensee makes an application for extending a facility license, an application for license renewal or amendment or for a new license would be submitted and reviewed according to appropriate existing regulations. This is not considered to be decommissioning and therefore is outside the scope of this EIS.

High-level waste repositories, low-level waste burial facilities, and uranium mills and their associated mill tailings piles are covered in separate rulemakings and are not included here. The first two items are covered in Title 10 of the Code of Federal Regulations (10 CFR) Parts 60 and 61. The last item is covered in amendments to 10 CFR Part 40.

REGULATORY OBJECTIVE

It is the responsibility of the NRC to ensure, through regulations and other guidance, that appropriate procedures are followed in decommissioning to protect the health and safety of the public. Present regulatory requirements and guidance cover the requirements and criteria for decommissioning in a limited way and are not adequate to regulate decommissioning actions effectively. Areas needing further criteria include decommissioning alternatives, financial assurance, planning and residual radioactivity levels as discussed below:

Decommissioning Alternatives. It is the responsibility of the NRC, in protecting public health and safety, to ensure that after a nuclear facility ceases operation its license is terminated in a timely manner. License termination requires decommissioning. Analysis of the technical data base, establishes that decommissioning can be accomplished and the facility released for unrestricted use shortly after cessation of operations or, in certain situations for certain facilities, delayed and completed after a period of storage. These situations would include considerations where the potential exists for occupational exposure and waste volume reduction, resulting from radioactive decay, or the inability to dispose of waste due to lack of disposal capacity, or other site specific factors which may affect safety. Completing decommissioning and releasing the site for unrestricted use eliminates the potential problems that may result from an increasing number of sites contaminated with radioactive material, as well as eliminating potential health, safety, regulatory, and economic problems associated with maintaining the nuclear facility.

Based on the technical data base, it appears that completing decommissioning shortly after cessation of facility operations or delaying completion of decommissioning for a 30 to 50 year period are reasonable options for decommissioning light water power reactors. Delay beyond that period may be acceptable if there is an inability to dispose of waste due to lack of disposal capacity or if there are site specific factors affecting safety such as if the safety of an adjacent reactor might be affected by dismantlement procedures.

For research and test reactors and for nuclear facilities licensed under 10 CFR Parts 30, 40, 70, and 72, occupational doses would be in most cases much less significant than power reactors. Thus, completing decommissioning shortly after cessation of operations is considered the most reasonable option. Delaying completion of decommissioning to allow short lived nuclides to decay may be justified in some cases, however, any extended delay would rarely be justifiable.

Financial Assurance. Consistent with the regulatory objective of decommissioning as described above, reasonable assurance is required from the nuclear facility licensee that adequate funds are available to decommission the facility. The funding mechanisms considered reasonable for providing the necessary assurance include prepayment of funds into a segregated account, insurance, surety bonds, letters of credit, and certain other guarantee methods, and a sinking fund deposited into a segregated account.

Planning. Planning for decommissioning is a critical item for ensuring that the decommissioning activities can be accomplished in a safe and timely manner. Development of detailed plans at the application stage is not possible because many factors (e.g., technology, regulatory requirements, economics) will change before the license period ends. Thus, most of the planning for the actual decommissioning will occur near final shutdown. However, a certain amount of preliminary planning should be done at the application stage.

Information on decommissioning funding provisions must be submitted with an application for a license for a nuclear facility. This information should include the method of assuring funds for decommissioning (as discussed above under Financial Assurance) and an indication of the amount being set aside. Provisions should also be made to adjust cost levels and associated funding levels over the life of the facility.

Facilitation of decommissioning in the design of a facility or during its operation can be beneficial in reducing operational exposures and waste volumes requiring disposal at the time of decommissioning. Although many aspects of facilitation can be covered under existing regulations, specific requirements that records of relevant operational and design information important to decommissioning be maintained should be added.

A final detailed decommissioning plan is required for review and approval by the NRC prior to cessation of facility operation or shortly thereafter. Besides the description of the decommissioning alternative which will be used, the final plan should include a description of the plans to ensure occupational and public safety and to protect the environment during decommissioning; a description of the final radiation survey to ensure that remaining residual radioactivity is within levels permitted for releasing the property for unrestricted use; an updated cost estimate; and for certain facilities as appropriate a description of quality assurance and safeguards provisions. The plan should include an estimate of the cost required to accomplish the decommissioning.

Residual Radioactivity Levels. The selection of an acceptable level is outside the scope of rulemaking supported by this EIS. The Commission is participating in an EPA organized interagency working group which is developing Federal guidance on acceptable residual radioactivity for unrestricted use. Proposed Federal guidance is anticipated to be published by EPA. NRC is planning to implement this guidance through rulemaking as soon as possible, as well as by issuing regulatory guides and standard review plan sections. Currently, criteria for residual contamination levels do exist and research and test reactors are being decommissioned using present guidance contained in Regulatory Guide 1.86 for surface contamination plus 5 μr/hr above background measured at 1 meter from the surface for direct radiation. The cost estimate for decommissioning can be based on current criteria and guidance regarding residual radioactivity levels for unrestricted use. The information in the studies performed as part of the reevaluation on decommissioning have indicated that in any reasonable range of residual radioactivity limits, the cost of decommissioning is relatively insensitive to the radioactivity level and use of cost data based on current criteria should provide a reasonable estimate. Even in situations where the residual radioactivity level might have an effect on decommissioning cost, by use of update provisions in the rulemaking, it is expected that the decommissioning fund available at the end of facility life will approximate closely the actual cost of decommissioning.

ENVIRONMENTAL IMPACT STATEMENT

Generally, the major environmental impact from decommissioning, especially for power reactors, occurs when the decision is made to operate the reactor. Provided decommissioning rules are in place and based on the conclusions of Chapters 4 and 5 regarding impacts from reactor decommissioning alternatives, it is not expected that any significant environmental impacts will result from decommissioning. Therefore current 10 CFR Part 51 needs to be amended to delete the manditory EIS requirement for decommissioning of power reactors. An EIS may still be needed but this should be based on site specific factors. Consequently a licensee should submit a supplemental environmental report and safety analysis and, based on these submittals, the NRC should consider preparation and issuance of an environmental assessment and a finding of no environmental impact. This is expected to be reasonable for most situations.

It is imperative that decommissioning rule amendments in 10 CFR Parts 30, 40, 50, 51, 70, and 72 be issued at this time because it is important to establish financial assurance provisions, as well as other decommissioning planning provisions, as soon as possible so that funds will be available to carry out decommissioning in a manner which protects public health and safety. Based on this need for the decommissioning provisions currently existing as well as those contained in the proposed rule amendments, the Commission believes that the rule can and should be issued now.

CONCLUSIONS ON DECOMMISSIONING IMPACTS

Consideration of the decommissioning data base including comments on the Draft Generic Environmental Statement and on the proposed rule and of the need for regulatory activity has led to the following conclusions in the Final Generic Environmental Impact Statement:

(1) The technology for decommissioning nuclear facilities is well in hand and, while technical improvements in decommissioning techniques are to be expected, decommissioning at the present time can be performed safely and at reasonable cost. Radiation dose to the public due to decommissioning activities should be very small and be primarily due to transportation of

decommissioning waste to waste burial facilities. Radiation dose to decommissioning workers should be a small fraction of their exposure experienced over the operating lifetime of the facility and be well within the occupational exposure limits imposed by regulatory requirements. Decommissioning costs are reasonable and are, at least for the larger facilities such as reactors, a small fraction of the present worth commissioning costs (i.e., less than 10%).

(2) Decommissioning of nuclear facilities is not an imminent health and safety problem. However, planning for decommissioning as an integral activity prior to commissioning as well as during facility life is a critical item that can have an impact on health and safety as well as cost. Essential to such planning activity is reasonable assurance that funds will be available for performing required decommissioning activities at the cessation of facility operation.

(3) Decommissioning of a nuclear facility generally has a positive environmental impact. At the end of facility life, termination of a nuclear license is the goal. Termination requires decontamination of the facility so that the level of any residual radioactivity remaining in the facility or on the site is low enough to allow unrestricted use of the facility and site. Commitment of resources, compared to operational aspects, is generally small. The major environmental impact of decommissioning is the commitment of small amounts of land for waste burial in exchange for reuse of the facility and site for other purposes. Since in many instances, such as at a reactor facility, the land is a valuable resource, return of this land to the commercial or public sector is highly desirable.

INCORPORATION OF EIS CONCLUSIONS IN REGULATIONS

It is recommended that specific implementation of regulatory activities be performed by rulemaking as amendments to existing regulations (i.e., 10 CFR Parts 30, 40, 50, 51, 70 and 72) rather than as a separate regulation solely covering decommissioning. Because decommissioning overlaps so many areas covered by present regulations, such incorporation would be more efficient.

ORGANIZATION OF THE EIS

Sections 1 to 3 of the main text of the EIS contain material common to all the facilities considered and should be read for discussion of generic issues. Sections 4 to 14 contain specific facility considerations. These separate facility sections were kept as self-contained as possible (recognizing that some redundancy would be inevitable for such an organizational approach), so that a user interested in a particular facility type need primarily read only that section, as well as introductory, generic, and policy sections. Section 15 contains details on how the conclusions of the EIS will affect regulatory policy considerations. The last section of the EIS is a glossary which provides the reader definitions of terms used in this report, including those used in a special sense in this report. Finally, in the Appendices, discussion and resolution of comments on the DGEIS is presented in Appendix A along with the original comments presented in Appendix B.

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1 INTRODUCTION

Commercial nuclear facilities that come under the Nuclear Regulatory Commission's (NRC) regulatory authority include those dealing with fuel cycle and non-fuel-cycle operation. The generation of electric power from steam supplied by nuclear reactors requires a series of processes collectively known as the nuclear fuel cycle. This cycle begins with the mining and milling of uranium ore, includes the operation of power reactors, and ends with the disposition of radioactive wastes. Each step in the cycle requires the handling of radioactive materials, which are specifically designated as source materials, byproduct materials, or special nuclear materials. Non-fuel-cycle facilities can also use byproduct, source, and special nuclear materials. Non-fuel-cycle facilities include those involved in academic, pharmaceutical and industrial radioisotopic use and in rare metal ore processing. The handling of these materials and the processes involved have given rise to several issues of fundamental importance to the American public. These issues include the safe operation of all steps in the nuclear fuel cycle and of other nuclear facilities, especially the safe operation of power reactors; the safe disposition of radioactive wastes; and the safe decommissioning of all nuclear facilities. The first two issues have received much attention from Congress and from federal regulatory agencies, beginning in 1954 with the passage of the Atomic Energy Act. The third issue, decommissioning, is now receiving an increasing amount of attention because the nuclear field is maturing, in that nuclear facilities have been operating for a number of years, and the number and complexity of facilities that will require decommissioning is expected to increase in the future. It is this third issue which is the subject of this document.

1.1 Purpose of EIS

The purpose of this environmental impact statement (EIS) is to assist the Nuclear Regulatory Commission (NRC) in developing policies and in promulgating amended regulations with respect to the decommissioning of licensed nuclear facilities. It is prepared pursuant to the requirements of the National Environmental Policy Act (NEPA). The decommissioning of uranium mills and mill tailings, (this includes all facilities associated with extracting uranium from areas, such as in situs, heap leach, and milling facilities) low-level waste burial facilities and high-level waste repositories has been treated in 10 CFR Parts 40, 60 and 61. In addition, also excluded from this action are uranium mines which come under the jurisdiction of the states and other Federal agencies. The generic analyses of this EIS are applicable to specific facilities based on the decommissioning information base studies which included sensitivity analyses of such parameters as the size of the facility, contamination level, waste disposal costs, labor costs, etc. (See References of Section 1)

1.1.1 NEPA Requirements

Section 102(1) of the National Environmental Policy Act (42 U.S.C. 4321 et seq.) requires that "the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act." Section 102(2)(C) requires all agencies of the Federal

Government to "include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on:

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

1.2 Organization of the EIS

The first three sections of this EIS contain material common to all of the facilities discussed in the statement. Regulatory matters are discussed in Section 1. Section 2 discusses in a generic manner the following: nuclear facilities; decommissioning alternatives; acceptable residual radioactivity levels for permitting release of the site for unrestricted use; financial assurance that sufficient funds are available for decommissioning; the management of radioactive wastes; and safeguards. Facility sites (i.e., the affected environment) are discussed generically in Section 3. Reactor facilities are discussed in Sections 4 through 8. Fuel cycle facilities are discussed in Sections 9 through 13 and non-fuel-cycle facilities in Section 14. These sections include descriptions of each facility, discussions of decommissioning alternatives, and summaries of radiation exposures and decommissioning costs. Other environmental consequences are also discussed. Regulatory policy considerations are discussed in Section 15.

It is intended in this report to provide a document sufficient in detail to be useful to the NRC in establishing policies and in promulgating amended regulations, yet not so lengthy or detailed as to be overwhelming to the general public and to others who have a valid interest in the subject. Detailed reports have been prepared which constitute information bases on the technology, safety and costs of decommissioning of the nuclear facilities discussed in this report.[1-10] These facilities are pressurized water reactors, boiling water reactors, multiple reactor power stations, research and test reactors, fuel reprocessing plants, small mixed oxide fuel fabrication plants, uranium hexafluoride conversion plants, uranium fuel fabrication plants, independent spent fuel storage installations, and non-fuelcycle materials facilities. Many of those reports have been available for critical comment for some time, have been found to be useful as a data base, and have been used in preparation of decommissioning studies. The decommissioning of uranium mills and tailings piles is discussed in a separate EIS.[11] The decommissioning of low-level waste burial facilities is also discussed in a separate EIS.[12]

This EIS represents a compendium of what would otherwise have been many separate EIS's on the nuclear facilities considered in this report. To make the report more useful to the user, the separate facility sections (Section 4 through 14) were kept as self-contained as possible, so that a user interested in a particular facility type need primarily read only that section, as well as the introduction, the section on generic issues and the section on policy. Such an approach causes some unavoidable redundancy in presentation of information contained in the various facility sections. In addition, an overview of this report is presented to enable a user to gain a perspective of the objectives and conclusions reached in this report.

1.3 Purpose of Decommissioning

The purpose of decommissioning nuclear facilities is to take the facility safely from service and to reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of license. Alternative methods of accomplishing this purpose, and the environmental impacts of each alternative are discussed in this EIS.

1.4 Responsibility for Decommissioning

The responsibility for decommissioning a commercial nuclear facility belongs to the licensee. Regulatory and policy guidance for decommissioning is the responsibility of the NRC and is implemented either by the NRC or Agreement State as applicable.

1.4.1 Existing Criteria and Regulations for Decommissioning

Statutory authority for the regulation of activities related to the commercial nuclear fuel cycle is contained in the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) and the Energy Reorganization Act of 1974 (42 U.S.C. 5841 et seq.) and in subsequent amendments. Pursuant to these acts, the NRC has promulgated regulations which appear in Title 10 of the Code of Federal Regulations. The NRC has also published Regulatory Guides for the purpose of assisting applicants and licensees in carrying out their regulatory obligations.

Present regulations specifically pertaining to decommissioning are contained in 10 CFR Parts 40, 61, and 72 and in Section 50.33(f), Section 50.82, and Appendix F of 10 CFR Part 50. General guidance is contained in NRC Regulatory Guides 1.86 and 3.5 (Rev. 1) and in NRC staff guidelines.

1.4.2 Current Rulemaking Activities

The NRC is currently developing an explicit overall policy for decommissioning commercial nuclear facilities and amending its regulations in 10 CFR Chapter I to include more specific decommissioning guidance for production and utilization facility licensees and byproduct, source, and special nuclear material licensees.[13] On February 11, 1985, the NRC published a notice of proposed rulemaking on Decommissioning Criteria for Nuclear Facilities (50 FR 5600). The proposed amendments covered a number of topics related to decommissioning that would be applicable to 10 CFR Parts 30, 40, 50, 70, and 72 applicants and licensees. These topics included decommissioning alternatives, planning, assurance of funds for decommissioning, environmental review requirements, and residual radioactivity.

1.5 History, Background, and Experience With Decommissioning

Facilities identified with the portion of the nuclear fuel cycle between mining and reactor operation, uranium hexafluoride conversion plants and uranium fuel fabrication plants, call for relatively routine decommissioning procedures. These facilities usually contain low-level radioactivity which is well confined to the facility. Mixed oxide fuel fabrication plants involve plutonium and thus call for special procedures. Pressurized water reactors, boiling water reactors, fuel reprocessing plants, and spent fuel storage facilities contain high levels of radioactivity that require special precautions and procedures. The differences among research and test reactors that have a variety of functions and the complexity of non-fuel-cycle facilities that handle byproduct, source, or special nuclear materials depend on the activities carried out and the materials handled. However, their problems in decommissioning these facilities are more from the great number and variety, than in any technical difficulties.

Since 1960, five licensed power reactors, four demonstration reactors, six licensed test reactors, one licensed ship reactor, and 52 licensed research reactors and critical facilities have been or are being decommissioned by the methods discussed in this EIS. Forty-two research reactors and critical facilities have been dismantled. Only one power reactor, the Elk River demonstration reactor, has been completely dismantled. Three other demonstration power reactors of small size have been entombed. The decommissioning status of the more important reactors is listed in Table 1.5-1. Some military reactors are included, while licensed research reactors and critical facilities have been omitted.

Decommissioning experience with some of the specific types of facilities is limited, but a broad base of experience with various facilities exists which is generally relevant to the decommissioning of any type of nuclear facility. A sampling of non-reactor facilities which have been decommissioned is presented in Table 1.5-2.

Table 1.5-1 Summary of nuclear reactor decommissionings

Facility Name and Location	Reactor Type	Power Rating(a)	Type of Decommissioning	License Status	Monitoring System	Safe Storage Measures	Year Decommissioned	Other Information
HRE-1 (Homogeneous Reactor Experiment), Oak Ridge, TN	Fluid-fuel	1 MWt	Dismantled	-(b)	-	-	1954	-
HRE-2 (Homogeneous Reactor Experiment), Oak Ridge, TN	Fluid-fuel	<1 MWt	Dismantled	-	-	-	1954	-
ARE (Aircraft Reactor Experiment), Oak Ridge, TN	Fluid-fuel	1 MWt	Dismantled	-	-	-	1955	-
PM-2A (Portable Medium Power Plant), Greenland	PWR	10 MWt	Dismantled	-	-	-	1964	-
Hanford Production Reactors, Richland, WA	Graphite moderated, water cooled	-	Custodial Safe Storage (Lay-away), 4-Stand-by, 4-Retired	-	Continuous surveillance by DOE	Continuous maintenance by DOE	1965-1971	One planned for dismantling
CVTR (Carolina Virginia Tube Reactor), Parr, SC	Pressure tube, heavy water cooled and moderated	65 MWt	Passive Safe Storage (mothballed)	Byproduct State(c)	Periodic surveillance	Welded closure, locked doors, security fence	1968(d)	-
Hallam Nuclear Power Facility, Hallam NB	Graphite moderated, sodium cooled	256 MWt	Entombed	Operating authorization terminated	Periodic surveillance by DOE	Welded closure, concrete cover, weatherproofed	1969	Decommissioning took 3 years
Piqua Nuclear Power Facility, Piqua, OH	Organic cooled and moderated	45 MWt	Entombed	Operating authorization terminated	Periodic surveillance by DOE	Welded closure, concrete cover, waterproofed	1969	Decommissioning took 3 Years
BONUS (Boiling Nuclear Superheater Power Station, Ricon, PR	BWR with nuclear superheating	50 MWt	Entombed	Operating authorization terminated	Periodic surveillance by DOE	Welded closure, concrete cover, security fence	1970	-
Walter Reed Research Reactor, Washington, DC	AI Model L-54, homogeneous fuel	50 kWt	Dismantled	-	-	-	1971	-
Pathfinder, Sioux Falls, SD	BWR with nuclear superheating	190 MWt	Passive Safe Storage (mothballed) with steam plant conversion	Byproduct NRC(c)	Continuous security force(e)	Welded closure, security fence	1972	Decommissioning cost $3 7M
B&W, Lynchburg, VA	Pool	6 MWt	Partially Dismantled	Byproduct NRC	Continuous security force	Locked doors, security fence	1972	-
EBR-1 (Experimental Fast Breeder Reactor), Scottsville ID	Liquid metal cooled	-	Deactivated, decontaminated, converted for public access	-	-	-	1973	Dedicated a National Monument in 1966
Saxton Nuclear Experimental Facility, Saxton PA	PWR	23 MWt	Passive Safe Storage (mothballed)	Possession only(f)	Intrusion alarms	Welded closure, locked doors, security fence	1973	Decommissioning cost $2 5M
SEFOR (Southwest Experimental Fast Oxide Reactor), Strickler, AR	Sodium cooled, fast	20 MWt	Passive Safe Storage (mothballed)	Byproduct State	Intrusion alarms	Welded closure, locked doors, security fence	1973	-
Elk River Reactor Elk River, MN	BWR with fossil superheating	58 MWt	Dismantled with steam plant conversion	Terminated(g)	Not required	Not required	1974	Decommissioning cost $6 15M; took 3 years
ASTR (Aerospace Test Reactor), U.S. Air Force, NARF, Ft Worth, TX	-	10 MWt	Dismantled	-	-	-	1974	-
GTR (Ground Test Reactor), U.S Air Force, NARF, Ft Worth, TX	-	10 MWt	Dismantled	-	-	-	1974	-
RTA (Reactivity Test Assembly), U.S. Air Force, NARF, Ft. Worth, TX	-	1 MWt	Dismantled	-	-	-	1974	-
FERMI 1, Monroe Co MI	Sodium cooled, fast	200 MWt	Passive Safe Storage (mothballed) with steam plant conversion	Possession only	Continuous security force	Locked doors, security fence	1975	Decommissioning cost $6 95M
PM-3A (Portable Medium Power Plant), Antarctica	PWR	9 MWt	Dismantled	-	-	-	1977	-
HTR (Hanford Test Reactor) Richland, WA	Graphite moderated	Zero Power	Dismantled	-	-	-	1977	Decommissioning cost $0 14M
IRL (Industrial Reactor Laboratories Inc. Research Reactor), Plainsboro NJ	Pool	5 MWt	Partially dismantled	-	-	Unrestricted use	1977	Decommissioning cost $1M; took 2 years
GE EVESR, Alameda Co CA	BWR with nuclear superheating	17 MWt	Passive Safe Storage (mothballed)	Possession only	Continuous security force	Locked doors, security fence	-	-
NASA Plumbrook, Sandusky OH	Light water	100 kWt	Passive Safe Storage (mothballed)	Possession only	Continuous security force	Locked doors, security fence	-	-
Peach Bottom 1 York Co PA	Gas cooled graphite moderated	115 MWt	Passive Safe Storage (mothballed)	Possession only	Continuous security force	Not yet established	-	
VBWR (Vallecitos Boiling Water Reactor), Alameda Co., CA	BWR	50 MWt	Passive Safe Storage (mothballed) with steam plant conversion	Possession only	Continuous security force	Locked doors, security fence		-
Westinghouse Test Reactor Waltz Mills, PA	Tank	60 MWt	Passive Safe Storage (mothballed)	Possession only	Continuous security force	Locked doors, security fence	-	-
SRE (Sodium Reactor Experiment), Santa Susana, CA	Graphite moderated, sodium	30 MWt	Passive Safe Storage (mothballed - 1967) dismantling started 1976	-	-	-	Dismantling in progress	Decommissioning costs expected to be ~$10M

(a)Power ratings are given in thermal megawatts (MWt) or kilowatts(kWt).
(b)Dash indicates information is unavailable from the literature studies or is not applicable
(c)Byproduct licenses may be either "Byproduct NRC" issued in accordance with 10 CFR Part 30 or "Byproduct State" issued by an agreement state in accordance with authority granted by 10 CFR Part 150.
(d)First to be placed in passive safe storage (mothballed); provided significant experience in developing criteria and methods
(e)Implies the availability of other onsite security forces not specifically associated with the decommissioned facility Had such not been available, NRC may have required other control measures.
(f)Title 10 CFR Part 50 §50 82 provides the rules by which a licensee may amend his operating license to a possession-only license Once this possession-only license is issued, reactor operation is not permitted.
(g)The site is the first decommissioned commercial reactor to be approved by the government for unrestricted use

Table 1.5-2 Nonreactor nuclear facility decommissioning information

Facility	Location	Year Decommissioned	Type of Decommissioning
Polonium-210 Facilities (Units III & IV)	Miamisburg, Ohio	1950	Partial dismantlement; decontaminated to unrestricted release levels
Cave Facility (Radium-226 and Actinium-227 Processing Facility)	Miamisburg, Ohio	1967	Partial entombment, remainder decontaminated to unrestricted release levels
SM Facility (Space Programs Plutonium-238 Facility)	Miamisburg, Ohio	1972	Decontaminated and placed in passive safe storage (mothballed) awaiting final disposition by DOE
Plutonium Filter Facility (Building 12)	Los Alamos, NM	1973	Dismantled
Laboratory for Plutonium Criticality Studies (P-11)	Richland, WA	1974	Dismantled
Plutonium Physics Study Building No 21	Los Alamos, NM	1975	Dismantled

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*Copies of all referenced Federal documents may be purchased through the U.S. Government Printing Office by calling (202) 275-2060 or by writing to the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082. Copies may also be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. A copy is available for inspection or copying for a fee in the NRC Public Document Room, 1717 H Street NW, Washington, DC 20555.

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2 GENERIC NUCLEAR FACILITY DECOMMISSIONING CONSIDERATIONS

In this section consideration is given to generic items required for implementing a decommissioning program for the facilities considered in this EIS. First, for an overview, a brief discussion is presented of the nuclear fuel cycle for light-water-reactors. Research and test reactors and non-fuel-cycle nuclear facilities are also briefly discussed. Consideration is then given to:

(1) decommissioning alternatives and their advantages and disadvantages,

(2) acceptable residual radioactivity levels for permitting release of a decommissioned nuclear facility for unrestricted access,

(3) assurance that funds to pay for decommissioning will be available,

(4) waste management for radioactive waste needing to be disposed of during nuclear facility decommissioning, and

(5) safeguarding requirements during decommissioning.

2.1 Nuclear Facilities Operational Description

2.1.1 The Nuclear Fuel Cycle

A nuclear power plant is a facility designed to generate electricity by utilizing the heat produced by controlled nuclear fission of uranium and plutonium. This is the desired production step in the fuel cycle. It is preceded by several steps in the fuel cycle in which uranium ore is processed into fuel elements, and is followed by several steps in which fuel removed from the reactor is stored and then either reprocessed to recover usable fuel or disposed of in some manner. The basic steps in the nuclear fuel cycle are shown in Figure 2.1-1. Each box in the diagram represents a separate facility and each arrow represents the transportation of the product between facilities. Spent fuel is being stored at the reactor sites pending eventual disposal at spent fuel storage facilities or high-level waste repositories.

The steps in Figure 2.1-1 for the typical fuel cycle for power plants are described more fully below.

Milling

The uranium ores that are mined and milled in the United States are sedimentary deposits in which the uranium occurs as a coating on sand grains. Small quantities of radium and thorium are also found in the ore. The uranium content is only about 1 to 3 kg per tonne (2 to 6 lb per ton). The milling process dissolves the uranium and separates it from the sand. This involves crushing and grinding the ore, dissolving the uranium by acid or alkaline leach, and precipitating a semi-refined product, called yellowcake. The tailings from this process are mostly sand, but they also include the original quantities of radium, thorium, and other decay products that do not extract

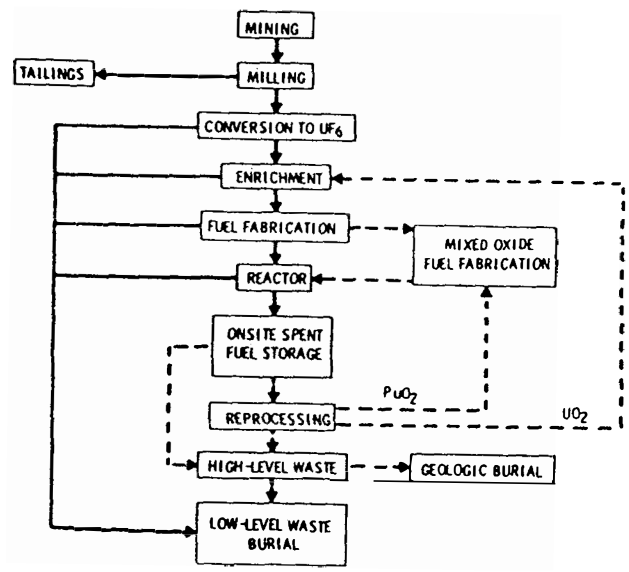

Figure 2.1-1 Diagram of the steps in the nuclear fuel cycle

with the uranium. The tailings are carried as a slurry to impoundment areas where the water is allowed to evaporate. The tailings are then stabilized to reduce future potential contamination problems.

Conversion

The yellowcake is shipped to a conversion plant where it is converted to UF_6 by one of two processes. One is the "dry" or hydrofluor process in which the yellowcake goes through a series of reduction, hydrofluorination, and fluorination steps in fluidized bed reactors. The other is a "wet" process in which the yellowcake is first processed to produce a high-purity uranium dioxide feed that undergoes reduction, hydrofluorination, and fluorination.

Enrichment

The UF_6 produced by the conversion process contains about 0.7% ^{235}U, which must be increased to 2 to 4% prior to fabrication into LWR fuel assemblies. Enrichment is accomplished by a gaseous diffusion process in which $^{235}UF_6$ molecules pass more readily through a porous membrane than do $^{238}UF_6$ molecules, thus producing a product stream that is enriched in $^{235}UF_6$. This process is repeated through many such stages until the desired degree of enrichment is attained. The enriched UF_6 is then shipped to a fuel fabrication plant.

Fuel Fabrication

In the preparation of LWR fuel, the enriched UF_6 first undergoes chemical treatment to convert it to UO_2. The UO_2 is mechanically and thermally treated to produce high-density ceramic fuel pellets that are placed in metal fuel tubes. These tubes or rods are then clustered into fuel assemblies for reactor cores.

Reactors

A light water reactor (LWR) as used in a power plant utilizes the heat produced by controlled nuclear fission within the fuel assemblies in the reactor core to heat water and generate steam which drives a turbine-generator. There are two basic LWR types: the pressurized water reactor (PWR) and the boiling water reactor (BWR). In a PWR the water in the reactor core is kept under pressure to allow heat build-up without boiling. This heated water is circulated through a heat exchanger where water in a second circulating system is converted to steam to drive the turbines. In a BWR the water in the reactor core is allowed to boil, directly producing the steam to drive the turbines.

Spent Fuel Storage Facilities

The partially depleted LWR spent fuel assemblies are removed from the reactor and stored in spent fuel pools at the reactor for a minimum of 90 days. This cooling period allows the short-lived radionuclides to decay and reduce the radioactivity and thermal heat emission of the fuel assemblies.

Spent fuel is currently being stored at reactor spent fuel pools for extended time periods as plans for further disposition of the spent fuel are being developed. Storage of spent fuel at away-from-reactor independent spent fuel storage installations (ISFSI) is being considered as an interim measure. One

ISFSI design is similar to that of the reactor storage pools except that the storage capacity is significantly greater. An alternative ISFSI design is to store the spent fuel in a dry storage environment such as an air-cooled vault.

Fuel Reprocessing

LWR spent fuel assemblies can be chemically reprocessed to separate the remaining uranium and the generated plutonium from the radioactive wastes produced during reactor operation. The chemical separation is accomplished by chopping the fuel rods into short sections, dissolving the pellets with nitric acid, extracting uranium and plutonium nitrates from the fission products, and then separating the uranium from the plutonium. The uranyl nitrate is converted to UF_6 and the plutonium nitrate is oxidized to plutonium dioxide. Both can then be inserted into the fuel cycle for reuse. At the present time no commercial spent fuel is being reprocessed in the United States.

Mixed Oxide Fuel Fabrication

A mixed oxide fuel fabrication plant produces fuel elements that contain a mixture of UO_2 and PuO_2. For example, UO_2 and PuO_2 powders are mixed and the mixture is formed into pellets by mechanical and thermal treatment. These pellets are sealed in metal cladding to form fuel elements. Only small mixed oxide plants are currently in use commercially and are used to fabricate experimental fuel elements.

Low-Level Waste Burial Facilities

Low-Level radioactive wastes which do not contain transuranic elements above certain concentrations are disposed of in shallow-land burial facilities. These kinds of materials may be generated at reactors or at any of the facilities where fuel is processed, and consist of contaminated trash, filters, and equipment. These wastes are placed in boxes or drums to facilitate handling and are buried at sites that are monitored and are restricted from public access.

High-Level Waste Repositories

High-level wastes are either intact fuel assemblies that are being discarded after serving their useful life in a reactor core (spent fuel) or certain fission product and actinide wastes generated during fuel reprocessing. High-level waste burial at deep geologic repositories is currently under consideration. There are currently no facilities of this type.

2.1.2 Research and Test Reactors

A research reactor is defined in 10 CFR 170.3(h) as a nuclear reactor licensed for operation at a thermal power level of 10 megawatts or less, and which is not a testing facility. A testing facility (i.e., a test reactor) is defined in 10 CFR 50.2 as a nuclear reactor licensed for operation at: (1) a thermal power level in excess of 10 megawatts, or (2) a thermal power level in excess of 1 megawatt if the reactor is to contain: a circulating loop through the core in which the applicant proposes to conduct fuel experiments, or a liquid fuel loading, or an experimental facility in the core in excess of 16 square inches in cross-section. There are 84 nonpower research and test (R&T) reactors in the U.S. that are licensed by the NRC. Of these 76 are research reactors, and

8 are test reactors. The level of activity of these facilities ranges from no longer operational, to occasional use, to intermittent use, to steady and scheduled use.

2.1.3 Non-Fuel-Cycle Nuclear Facilities

Non-fuel-cycle facilities are those facilities which handle by-product, source and/or special nuclear materials, but which are not involved in the production of power as outlined in Figure 2.1-1. Non-fuel-cycle facilities must be licensed by the NRC. Precise definitions and licensing requirements for the materials listed above are published in 10 CFR Parts 30, 40, and 70, respectively. Broadly speaking, source materials consist of uranium and thorium, special nuclear materials consist of plutonium or enriched uranium, and byproduct materials consist of materials made radioactive by special nuclear material. These facilities include a wide range of applications in industry, medicine and research such as manufacture of packaged products containing small sealed sources and of radiochemicals, research and development institutions, and processors of ores in which the tailings contain licensable quantities of radionuclides.

2.2 Facilities Considered in EIS

The facilities considered in this EIS are: (1) pressurized water reactors, (2) boiling water reactors, (3) multiple reactor stations, (4) research and test reactors, (5) fuel reprocessing plants, (6) small mixed oxide fuel fabrication plants, (7) uranium hexafluoride conversion plants, 8) uranium fuel fabrication plants, (9) independent spent fuel storage installations, and (10) non-fuel-cycle nuclear facilities. The facilities not considered include uranium mills and mill tailings, low-level waste burial facilities and high-level waste repositories because they are covered by separate rulemaking; and uranium mines and the existing government owned uranium enrichment plants because they are not under NRC jurisdiction.

2.3 Definition of Decommissioning

Decommissioning means to remove a nuclear facility safely from service and to reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. Decommissioning activities do not include the removal and disposal of spent fuel which is considered to be an operational activity or the removal and disposal of nonradioactive structures and materials beyond that necessary to terminate the NRC license. Disposal of nonradioactive hazardous waste not necessary for NRC license termination is not covered in detail by this EIS but would be treated by other agencies having responsibility over these wastes as appropriate.

2.4 Decommissioning Alternatives

Once a nuclear facility has reached the end of its useful life, it must be decommissioned according to the definition contained in Section 2.3. Several alternatives are possible, although not all may be satisfactory for all nuclear facilities. These alternatives are: no action, DECON, SAFSTOR, and ENTOMB. The terms DECON, SAFSTOR, and ENTOMB are relatively new in use. In the past, the nomenclature for describing these alternatives has not been consistent. Different documents have often used different terminology when referring to the same decommissioning alternative, thus causing some confusion. In the interest of ending the confusion, this section lists the following definitions of the major decommissioning alternatives and the following pseudoacronyms to clearly delineate each alternative:

DECON is the alternative in which the equipment, structures, and portions of the facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.

SAFSTOR is the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

ENTOMB is the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting release of the property for unrestricted use.

Table 2.4-1 presents a summary of the various activities that will be in effect during DECON, SAFSTOR and ENTOMB.

Conversion to a new or modified use is also considered. Conversion, however, is not considered to be a decommissioning alternative whether the new use involves radioactivity or not. If the intended new use involved radioactive material and, thus was under NRC licensing authority, an application for license renewal or amendment or for a new license would be submitted and reviewed according to appropriate existing regulations. If the intended new use does not involve radioactive materials, i.e., unrestricted public use, then such new use would be contingent on prior decommissioning and termination of license. As such, it would have to use one of the decommissioning alternatives indicated above, namely DECON, SAFSTOR, or ENTOMB. In this case, the new use except as it affects the decommissioning alternative chosen. For these reasons, conversion to a new or modified facility is not considered further in this EIS.

2.4.1 No action

The objective of decommissioning is to restore a radioactive facility to a condition such that there is no unreasonable risk from the decommissioned facility to the public health and safety. In order to ensure that at the end of its life the risk from a facility is within acceptable bounds, some action is required, even if it is as minimal as making a terminal radiation survey to verify the radioactivity levels and notifying the NRC of the results of the survey. Thus, independent of the type of facility and its level of contamination, No Action, implying that a licensee would simply abandon or leave a facility after ceasing operations, is not a viable decommissioning alternative. Therefore, because no action is not considered viable for any facility discussed in this EIS, this alternative is not considered further in this report.

2.4.2 DECON

DECON is the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or

Table 2.4-1 Summary of the elements of the decommissioning alternatives

Elements[a]	Facility Status	Comments, Facility/Site Use
Decontamination [to levels permitting unrestricted use of the facility]	Equipment - removed if radioactive Continuing Care Staff - none Security - none Environmental Monitoring - none Radioactivity - removed Surveillance - none Structures - removal optional	Facility - Unrestricted use reaching permissible levels Site - Unrestricted use after reaching permissible levels
Safe Storage		
Custodial (Layaway)	Equipment - some operating Continuing Care Staff - some required Security - continuous Environmental Monitoring - continuous Radioactivity - confined Surveillance - continuous Structures - intact	Safe storage alone is not an acceptable decommissioning mode; it must be followed by decontamination to unrestricted use. Facility - Nuclear Only Site - Nuclear Only
Passive	Equipment - none operating Continuing Care Staff - optional (onsite) - routine inspections Security - remote alarms Environmental Monitoring - routine periodic Radioactivity - immobilized/sometimes sealed Surveillance - periodic Structures - intact	Facility - Nuclear Only Site - Conditional Non-nuclear

Table 2.4-1 (Continued)

Elements[a]	Facility Status	Comments, Facility/Site Use
Hardened	Equipment - none operating Continuing Care Staff - none on site Security - hardened barriers, fencing and posting Environmental Monitoring - infrequent Radioactivity - hardened sealing Surveillance - infrequent Structures - partial removal optional	Facility - Conditional Non-nuclear Site - Conditional Non-nuclear
<u>Entombment</u>	Equipment - some removed, the rest encased in concrete Site - unrestricted Continuing Care Staff - none Security - hardened barriers Environmental Monitoring - infrequent Radioactivity - encased in concrete Surveillance - infrequent Structures - intact	Facility - Unusable for an extended time period Site - Unrestricted use

[a]Elements are the specific activities involved in each of the decommissioning alternatives, e.g., SAFSTOR is made up of the following elements: preparation for safe storage, safe storage and decontamination.

decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations. DECON is the only one of the decommissioning alternatives presented here which leads to termination of the facility license and release of the facility and site for unrestricted use shortly after cessation of facility operations. DECON is estimated to take from fairly short time periods for small facilities to up to approximately 6 years for a large LWR.

Because all of the DECON work is completed within a few months or years following shutdown, personnel radiation exposures are generally higher than for other decommissioning alternatives which spread the decommissioning work over longer time periods thus allowing for radioactive decay. Similarly, larger commitments of money and waste disposal site space are also required for DECON in a relatively short time frame compared to the other alternatives.

Thus, the primary advantage of DECON, which is terminating the facility license and making the facility and site available for some other beneficial use, is accomplished at the expense of larger initial commitments of money, personnel radiation exposure, and waste disposal site space than for the other alternatives. Other advantages of DECON include the availability of a work force highly knowledgeable about the facility and the elimination of the need for long-term security, maintenance and surveillance of the facility which would be required for the other decommissioning alternatives.

In DECON, nonradioactive equipment and structures need not be torn down or removed as part of a decontamination procedure for termination of the NRC license and release for unrestricted use. Once the radioactive facility structures are decontaminated to radioactivity levels permitting unrestricted use of the facility, they may either be put to some other use or demolished at the owner's option.

2.4.3 SAFSTOR

SASTOR is the alternative in which the nuclear facility is placed (preparation for safe storage) and maintained in a condition that allows the nuclear facility to be safely stored (safe storage) and subsequently decontaminated to levels that permit release for unrestricted use (deferred contamination). SAFSTOR consists of a short period of preparation for safe storage (up to 2 years after final reactor shutdown), a variable safe storage period of continuing care consisting of security, surveillance, and maintenance (up to 60 years after final shutdown depending on the type of facility), and including a short period of deferred decontamination. Several subcategories of SAFSTOR are possible:

1. Custodial SAFSTOR requires a minimum cleanup and decontamination effort initially, followed by a period of continuing care with the active protection systems (principally the ventilation system) kept in service throughout the storage period. Full-time onsite surveillance by operating and security forces is required to carry out radiation monitoring, to maintain the equipment, and to prevent accidental or deliberate intrusion into the facility and the subsequent exposure to radiation or the dispersal of radioactivity beyond the confines of the facility.

2. Passive SAFSTOR requires a more comprehensive cleanup and decontamination effort initially, sufficient to permit deactivation of the active

protective (ventilation) system during the continuing care period. The structures are strongly secured and electronic surveillance is provided to detect accidental or deliberate intrusion. Periodic monitoring and maintenance of the integrity of the structures is required.

3. Hardened SAFSTOR requires comprehensive cleanup and decontamination and the construction of barriers around areas containing significant quantities of radioactivity. These barriers are of sufficient strength to make accidental intrusion impossible and deliberate intrusion extremely difficult. Surveillance requirements are limited to detection of attack upon the barriers, to maintenance of the integrity of the structures, and to infrequent monitoring.

All categories of safe storage require some positive action at the conclusion of the period of continuing care to release the property for unrestricted use and terminate the license for radioactive materials. Depending on the nature of the nuclear facility and its operating history, the necessary action can range from a radiation survey that shows that the radioactivity has decayed and the property is releasable, to dismantlement and removal of residual radioactive materials. These latter actions, whatever their scale, are generically identified as deferred decontamination.

SAFSTOR is used as a means to satisfy the requirements for protection of the public while minimizing the initial commitments of time, money, occupational radiation exposure, and waste disposal space. In addition, SAFSTOR may have some advantage where there are other operational nuclear facilities at the same site, and may also become necessary in other situations if there is a shortage of radioactive waste disposal space offsite. Modifications to the facilities are limited to those which ensure the security of the buildings against intruders, and to those required to ensure containment of radioactive or toxic material. It is not intended that the facilities will ever be reactivated. In highly contaminated facilities and/or facilities with large amounts of activation products, there is the potential for incurring larger occupational radiation exposures if complete decontamination is performed immediately after shutdown (DECON). However, as a result of radioactive decay of this contamination, reductions in personnel exposure and simplifications in the complexity of operations can be achieved by deferring major decontamination efforts for a number of years. Also, because many of the contamination and activation products present in the facility will have decayed to background levels after a lengthy storage period, the volume of material that must be packaged for disposal will be reduced.

The reduced initial effort (and cost) of the preparation of safe storage is tempered somewhat by the need for continuing surveillance and physical security to ensure the protection of the public. Electronic surveillance devices, which are presently available, could be in service fulltime, with offshift readouts in a local law enforcement office or private security agency. These devices which monitor for intruders, increases in radiation levels, and detection of fires will require periodic checks and maintenance.

Maintenance of the facility's structures and an ongoing program of environmental surveillance are also necessary. The duration of the storage and surveillance and dismantlement period can vary from a few years to up to 60 years depending on the type of facility. If SAFSTOR is used, the decision on the length of the safe storage period will be made by the facility owner, with the approval of the NRC, based on consideration of factors including desirability of terminating the license, radiation dose and waste volume reductions, availability of waste disposal capacity, and other site specific factors affecting safety, such as presence of other nuclear facilities at the site. Similarly, the decision on the extent of decontamination during the period of preparation for safe storage, and the resultant subcategory of SAFSTOR to be used, depends upon safety considerations and the planned length of the storage and surveillance period. If for example, ^{60}Co is the controlling source of occupational exposure, a chemical decontamination campaign achieving a decontamination factor (DF) of 10 (i.e., radioactivity levels reduced to 1/10 of original) will result in approximately the same dose reduction as a decay period of 17 years.

At the end of the period of safe storage, several things will remain to be done before the facility can be released for unrestricted use. In most cases, radioactivity in some areas within the facility will be significantly above levels acceptable for unrestricted release of the facility, necessitating the removal, packaging and disposal of selected materials at a regulated disposal site. If the safe storage period is sufficiently long, radioactive materials in the facility may have decayed to levels low enough to permit the facility to be released for unrestricted use without additional decontamination. This would not apply in the case of a reactor, if the reactor had been operated long enough to produce significant amounts of the long-lived isotopes ^{59} Ni and ^{94}Nb.

Deferred decontamination, even for a major facility such as a LWR, is a relatively straight-forward disassembly job complicated by whatever radioactivity remains. Removal and transport of the materials containing the radioactivity to a disposal site are the principal tasks that must be completed. Further action following termination of the NRC license and release for unrestricted use, such as disassembly of the various non-radioactive systems and use or demolition of the buildings, would be at the owner's discretion.

A disadvantage of SAFSTOR is the potential lack of personnel familiar with the facility at the time of deferred decontamination. More time and training would be needed. One potential solution to this problem would be the establishment of companies specializing in the decommissioning of nuclear reactor power station and other nuclear facilities. Other disadvantages include the fact that the site is tied up in a non-useful purpose for extended time period, regulatory uncertainties in the future, and the continuing need for maintenance, security and surveillance.

2.4.4 ENTOMB

ENTOMB is the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting release of the property for unrestricted use. ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within reasonable time periods (i.e., within the time period of continued structural integrity of the entombing structure as well as confidence in the reliability of continued radioactivity containment and access restriction, perhaps the order of 100 years). However, a few radioactive isotopes found in fuel reprocessing plants, nuclear reactors, fuel storage facilities, and mixed oxide facilities have half-lives in excess of 100 years and the radioactivity will not decay to levels permitting release of the facilities for unrestricted use within the foreseeable lifetime of any man-made structure. Thus, the basic requirement of continued structural integrity of the entombment cannot be ensured for these facilities, and ENTOMB would not be a viable alternative in these circumstances. On the other hand, if the entombing structure can be expected to last many half-lives of the most objectionable long-lived isotope, then ENTOMB becomes a viable alternative because of the reduced occupational and public exposure to radiation. However, even in these circumstances, one of the difficulties with ENTOMB for any complex structure such as a reactor is that the radioactive materials remaining in the entombed structure would need to be characterized well enough to be sure that they will have decayed to acceptable levels at the end of the surveillance period. If this cannot be done adequately, deferred decontamination would become necessary, which would make ENTOMB more difficult and costly than DECON or SAFSTOR. Some method would have to be provided to demonstrate that the entombed radioactivity will decay to levels permitting release of the property for unrestricted use within the order of 100 years, which would be difficult. ENTOMB does, of course, contribute to the problems associated with increased numbers of sites dedicated for very long periods to the containment of radioactive materials.

2.5 Residual Radioactivity Levels for Unrestricted Use of a Facility

Decommissioning requires reduction of the radioactivity remaining in the facility to residual levels that permit release of the facility for unrestricted use and NRC license termination.

The Commission is participating in an EPA organized interagency working group which is developing Federal guidance on acceptable residual radioactivity levels for unrestricted use. Proposed Federal guidance is anticipated to be published by EPA. NRC is planning to implement this guidance through rulemaking as soon as possible. The selection of an acceptable level is outside the scope of rulemaking supported by this EIS. Currently, criteria for residual contamination levels do exist and research and test reactors are being decommissioned using present guidance contained in Regulatory Guide 1.86[5] for surface contamination plus 5 μr/hr above background as measured at 1 meter direct radiation. The NRC provided such criteria in letters to Stanford University, dated 3/17/81 and 4/21/82 providing "Radiation criteria for release of the dismantled Stanford Research Reactor to unrestricted access." The cost estimate for decommissioning can be based on current criteria and guidance regarding residual radioactivity levels for unrestricted use. The information in the studies by Battelle Northwest Laboratory and Oak Ridge National Laboratory on decommissioning have indicated that in any reasonable range of residual radioactivity limits, the cost of decommissioning is relatively insensitive to the radioactivity level and use of cost data based on current criteria should provide a reasonable estimate.

For example, in ORNL studies[1,2] for a PWR, certification surveys at realistic dose values 10 and 25 mrem/year were considered. It was indicated that a survey for the 10 mrem/year value was considered to be well within technical capability and could be done for a cost of approximately $250,000 (i.e., less than about 0.6% of estimated PWR decommissioning costs); and a survey for the 25 mrem/year value is estimated to cost not much less than that for 10 mrem/year (about $225,000).

There should be no significant additional decontamination effort required as a result of the termination survey, perhaps only cleanup of a few hot spots indicated by the survey. This is because the extensive efforts required to decontaminate the highly contaminated facility to low radioactivity level will result in residual radioactivity levels well below the limits which permit unrestricted release of the facility. It is also the case because spot surveys will be carried out periodically during the decommissioning period so that at the time of the termination survey the licensee is confident that decontamination efforts have achieved the acceptable residual radioactivity levels in most instances. Thus, because there should not be significant additional decontamination necessary after completion of the termination survey, the major cost and effort expected for verifying the required residual radioactivity levels for unrestricted facility use should come from the certification survey. As indicated above for the PWR example, these survey costs are expected to be a small fraction of the total decommissioning cost, and thus the effort to certify that the facility is available for unrestricted use should not add significantly to the overall decommissioning cost.

In addition, cost-benefit considerations are involved in the evaluation of the extent of facility decontamination necessary to reduce radioactive contamination to levels considered acceptable for releasing the facility for unrestricted use. As is discussed by PNL in NUREG/CR-0130,[3] and in NUREG/CR-0278,[4] and as is also inherent in the reports prepared by PNL for the other nuclear facilities discussed in this EIS, the cost of decontamination of a facility and thus its decommissioning cost, is essentially independent of the level to which it must be decontaminated as long as that level is in the range of 10 to 25 mrem/yr to an exposed individual. This is because, as indicated above, it is expected that the extensive efforts required to decontaminate the highly contaminated facility to low radioactivity levels will result in residual radioactivity level well below the limits to permit release of the facility for unrestricted use. An additional cost-benefit consideration relates to decontamination of rooms which are mildly contaminated with radioactivity. Most rooms should not be mildly contaminated with radioactivity in excess of levels which are acceptable for unrestricted facility use since it is assumed that good housekeeping and ALARA practices will be used during facility operations to control the spread of contamination. In areas where there is mild contamination, techniques such as having previously painted surfaces should make decontamination easier and less costly. A source of data for the evaluation of cost for decontamination of mildly contaminated rooms is in NUREG/CR-1754[6] which evaluates decontamination of a number of specific components. As an example, for a hot cell contaminated with Cs-137, the manpower needed for decontamination would be approximately 5 man-days and the associated costs would be approximately $5,000. Costs for decontamination of other specific components would be about the same order. These costs for decontamination of specific mildly contaminated components are small in comparison to the overall decommissioning costs. Therefore, based on the above discussions, while cost-benefit is a consideration, it is not expected to have a major impact on the GEIS results concerning reactor or most nonreactor decommissionings.

Even in situations where the residual radioactivity level might have an effect on decommissioning cost, by use of update provision in the rulemaking it is expected that the decommissioning fund available at the end of facility life will approximate closely the actual cost of decommissioning.

It is imperative that these decommissioning rule amendments in 10 CFR Parts 30, 40, 50, 70, and 72 be issued at this time because it is important to establish financial assurance provisions, as well as other decommissioning planning provisions, as soon as possible so that funds will be available to carry out decommissioning in a manner which protects public health and safety. Based on this need for the decommissioning rule and provisions currently existing and those contained in the rule amendments, the Commission believes that the rule can and should be issued now.

2.6 Financial Assurance

The primary objective of the NRC with respect to decommissioning is to protect the health and safety of the public. An important aspect of this objective is to have reasonable assurance that, at the time of termination of facility operations, adequate funds are available to decommission the facility in a safe and timely manner resulting in its release for unrestricted use, and that lack of funds does not result in delays in decommissioning that may cause potential health and safety problems for the public. The need to provide this assurance arises from the fact that there are uncertainties concerning the availability of funds at the time of decommissioning. The nuclear facility licensee has the responsibility for completing decommissioning in a manner which protects public health and safety. Satisfaction of this objective requires that the licensee provide reasonable assurance that adequate funds for performing decommissioning will be available at the cessation of facility operation.

2.6.1 Present Regulatory Guidance

Present regulatory requirements concerning the degree of financial assurance required of a licensee are not specific enough. 10 CFR 50.33(f) requires that, except for an electric utility applicant for a license to operate a utilization facility, an applicant for a production or utilization facility operating license demonstrate financial capability both to operate the facility and to shut it down and maintain it safely. 10 CFR 50, Appendix F, requires the applicant for a fuel reprocessing plant operating license to demonstrate his financial qualifications "to provide for removal and disposal of radioactive wastes during operation and upon decommissioning." 10 CFR 72 requires an applicant for a license for an independent spent fuel storage installation to provide information on funding for decommissioning. These regulations do not contain sufficient criteria for assuring funds for decommissioning the facilities covered by this EIS.

2.6.2 Implementation of Financial Assurance Requirements

In providing reasonable assurance that funds will be available for decommissioning, there are several possible financing mechanisms, outlined below, which are available to applicants and licensees. The many different types of nuclear facilities present a wide diversity in the cost of decommissioning, in the risk that decommissioning funds might be unavailable, and in the licensees' financial situations. This diversity necessitates that the NRC allow latitude in the implementation of these financing mechanisms. For example, the situation for a large power reactor can be significantly different from that for a small research or testing facility or for a materials license. Generally, for a power reactor, state utility commissions regulate retail rates and the Federal Energy Regulatory Commission regulates wholesale rates, permitting utilities to recover the cost of providing electricity from their customers. The decommissioning costs are higher than for small facilities, and the licensees are required by 50 CFR 10.54(w) to carry substantial levels of insurance for post-accident decontamination and cleanup. This is significantly different than the situation for a small non-fuel-cycle facility which is not rate regulated and has low decommissioning costs.

In analyzing funding methods, the NRC has developed the following major classification of funding alternatives.

(1) Prepayment - The deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets such that the amount of funds would be sufficient to pay decommissioning costs. Prepayment could be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

(2) Surety bonds, letters of credit, lines of credit, insurance, or other guarantee methods - These mechanisms guarantee that the decommissioning costs will be paid should the licensee default. The licensee still must provide funding for decommissioning through some other method. It appears questionable that surety methods of the size necessary and for the time involved with power reactors will be available. However, they appear to be available for facilities that involve smaller costs and periods. The contractual arrangement guaranteeing the surety methods, insurance, or guarantee must include provisions for insuring that these methods will in fact result in funds being available for decommissioning. It should be kept in mind that sureties would only be called if at the time of cessation of facility operation or impending discontinuance of surety by the guarantor, licensee decommissioning funds were inadequate or unavailable.

(3) External sinking funds - A fund established and maintained by setting funds aside periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected. An external sinking fund could be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. The weakness of the sinking fund approach is that in the event of premature closure of a facility the decommissioning fund would be insufficient. Therefore, the sinking fund would have to be supplemented by insurance or surety bonds, or letters or lines of credit or other guarantee methods of item (2).

(4) Internal reserve or unsegregated sinking fund - A fund established and maintained by the periodic deposit or crediting of a prescribed amount into an account or reserve which is not segregated from licensee assets and is within the licensee's administrative control in which the total amount of the periodic deposits or funds reserved plus accumulated earnings would be sufficient to pay for decommissioning at the time termination of operation is expected. In this mechanism, the funds are not segregated from the utility's assets, rather they may be invested in utility assets and, at the end of facility life, internal funds are used to pay for decommissioning by, for example, issuance of bonds against licensee assets and the funds raised are used to pay for decommissioning. An internal reserve may also

be in the form of an internal sinking fund which is similar to an external sinking fund except that the fund is held and invested by the licensee. Such a mechanism is generally considered to be less expensive in terms of net present value than the options listed above, although, as discussed below, whichever funding mechanism is used should not have a significant impact on the revenue requirements. The problem with the internal or unsegregated funding method is the lesser level of assurance that funds will be available to pay for decommissioning than the other mechanisms because this method depends on financing internal to the licensee, and therefore, is vulnerable to events that undermine the financial solvency of a utility.

The NRC has considered the use of all of these methods, and in particular internal reserve, in several documents. These include NUREG-0584, Revs. 1-3, "Assuring the Availability of Funds for Decommissioning Nuclear Facilities,"[7] NUREG/CR-1481, "Financing Strategies for Nuclear Power Plant Decommissioning,"[8] and NUREG/CR-3899, "Utility Financial Stability and the Availability of Funds for Decommissioning"[9]. In addition, the Commission held a meeting soliciting public and industry views of decommissioning on September 18, 1984 and the NRC staff has reviewed comments in the area of financial assurance submitted on NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning Nuclear Facilities" and submitted in response to the proposed rule on decommissioning (50 FR 5600)[10]

These reports and meetings and public comments considered several factors regarding availability of funds for public utilities in the United States. One factor is that utilities are large, very heavily capitalized enterprises whose rates are comprehensively regulated by the State Public Utility Commissions (PUC) and the Federal Energy Regulatory Commission (FERC). This factor permits the utilities to charge reasonable rates subject to reasonable regulation and rules. In addition, the Commission has taken action recently in the promulgation of 10 CFR 50.54(w) to set requirements to establish onsite property damage insurance for use after an accident. Although these insurance proceeds would not be used directly for decommissioning, they would reduce the risk of a utility being hit by a large demand for funds after an accident. Most utilities are now carrying insurance well in excess of $1 billion. Other factors considered are the long time period before decommissioning takes place during which time reasonable assurance of funds for decommissioning must be maintained, as well as concerns regarding utility solvency and potential problems regarding availability of funds which may occur as a result of bankruptcy.

Before publication of the proposed rule, the NRC evaluated the adequacy of various funding methods in light of financial problems encountered by some utilities which, faced with lower growth in electricity demand than they projected and rapidly increasing costs of construction, had been forced to cancel nuclear plants in advanced stages of construction and the ramifications these conditions, as well as issues related to bankruptcy, could have on a utility's ultimate ability to pay for decommissioning. Details of this evaluation are contained in NUREG/CR-3899, (Ref. 9) prepared by an NRC consultant, Dr. J. Siegel of the Wharton School, University of Pennsylvania.

Based on the results of NUREG/CR-3899 in which it is indicated that internal reserve can be a valid funding method and on the considerations discussed in the Supplementary Information to the Proposed Rule, the proposed decommissioning rule permitted a range of options, including internal reserve, for providing assurance that sufficient funds are available for decommissioning. However, the Supplementary Information to the proposed rule noted that the regulatory approach for assuring funds for decommissioning had been particularly difficult to resolve and specifically requested additional information and comments in this area. In particular, the Supplementary Information stated that:

> "More specifically, Commissioners Asselstine and Bernthal continue to be concerned about the vulnerability of the internal funding mechanism for decommissioning funds, particularly where the funds are used to purchase assets or reduce existing debt."

Based on this concern, Commissioners Asselstine and Bernthal requested "public comments on the need to consider the possibility of insolvency and its impact on the continued availability of decommissioning funds."

Although commenters did not generally refer specifically to the separate request for comment by Commissioners Asselstine and Bernthal, a number of comments, noted above, were received in this area. Those who disagreed with the inclusion of internal reserve in the rule cited problems with liquidity of the internal reserve and with the future financial viability of utilities with resultant problems in providing decommissioning funds, and stated that the level of assurance is inadequate. In contrast, other commenters agreed with the use of internal reserve citing the fact that the likelihood of instability and insolvency is remote, that utilities have investments, cash flow, and annual earnings which are large in comparison to decommissioning cost, and that the internal reserve does provide reasonable assurance.

As part of the review of the comments, NRC has had NUREG/CR-3899 updated to consider the current situation in the utility industry. This analysis is contained in NUREG/CR-3899, Supplement 1, (Ref. 9) which reviewed six utilities which have been subject to severe financial distress. Based on the analysis, NUREG/CR-3899, Supp. 1 indicates that, since NUREG/CR-3899 was published in 1984, the financial health of the nuclear utilities has improved, with the exception of Public Service of New Hampshire (PSNH), and that from a financial standpoint, use of internal reserve currently provides sufficient assurance of funds for decommissioning. The basis for this conclusion is the fact that the likelihood of future crises developing, although not impossible, is extremely remote; that the total market value of the securities of each of the six utilities studied substantially exceeds its decommissioning costs; that it is not necessarily true that bankruptcy of a utility is tantamount to default on decommissioning obligations; and the potential that the costs of decommissioning would be recognized as a prior obligation with regard to creditors.

Despite these conclusions, Supplement 1 notes that PSNH has said that, unless it undergoes financial restructuring and gets the rate increase it is seeking, it probably would become the first major utility to seek protection under the Bankruptcy Act in nearly 50 years.* In addition, Supplement 1 notes that if PSNH's Seabrook plant becomes operational, the prospects for PSNH greatly improve although bankruptcy still cannot be precluded as a possibility due to

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*Subsequent to the preparation of the analysis of NUREG/CR-3899, Supplement 1, PSNH filed a petition in bankruptcy under Chapter 11 of the U.S. Bankruptcy code.

the potential for large rate hikes and resultant defections from its electric system. Hence Supplement 1 concludes that internal reserve should not be allowed for Seabrook until the financial prospects of the utility are clarified and the viability of the corporation insured.

In addition, Supplement 1 noted that it is imperative that, in the case of the sale or other disposition of utility assets, no monies are distributed to any security holders until a fund is established to assure payment for decommissioning. Supplement 1 also recommended changes in Federal and State bankruptcy laws relating to utilities and the inclusion in the prospectus of newly issued securities of an explicit statement of the utility's financial obligations to provide adequate funds for decommissioning. Further, Supp. 1, noted that because of changing economic and financial conditions, the NRC should conduct periodic reviews of the overall financial health of utilities with ongoing and prospective nuclear facilities. If such a review indicates the financial condition of utilities taken as a whole or individually is such that internal reserve does not provide reasonable assurance of funds for decommissioning, then additional rulemaking or other steps should be taken to insure availability of these funds.

The Commission has considered the conclusions in NUREG/CR-3899, Supplement 1, as well as the public comments received on the issue. The Commission's review in this area is confined to its statutory mandate to protect the radiological health and safety of the public and promote the common defense and security which stems principally from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. In carrying out its licensing and related regulatory responsibilities under these acts, the NRC has determined that there is a significant radiation hazard associated with nondecommissioned nuclear reactors. The NRC has also determined that the public health and safety can best be protected if its regulations require licensees to use methods which provide reasonable assurance that, at the time of termination of operations, adequate funds are available so that decommissioning can be carried out in a safe and timely manner and that lack of funds does not result in delays that may cause potential health and safety problems. Although the Atomic Energy Act and the Energy Reorganization Act do not permit the NRC to regulate rates or to supersede the decisions of State or Federal agencies respecting the economics of nuclear power, they do authorize the NRC to take whatever regulatory actions may be necessary to protect the public health and safety, including the promulgation of rules prescribing allowable funding methods for meeting decommissioning costs. (See Pacific Gas & Electric v. State Energy Resources Conservation & Development Commission, 461 U.S. 190, 212-13, 217-19 (1983); see also United Nuclear Corporation v. Cannon, 553 F. Supp. 1220, 1230-32 (D.R.I. 1982) and cases cited therein.)

For the foregoing reasons, the Commission continues to be concerned with the use of an internal reserve. The Commission notes the concerns expressed in NUREG/CR-3899, Supp. 1 regarding bankruptcy at PSNH as well as the changing economic and financial conditions discussed in NUREG/CR-3899, Supp. 1. The Commission also notes that many utilities are engaging in diversified financial activities which involve more financial risk and believes therefore it is increasingly important to provide that decommissioning funds be provided on a more assured basis.

In addition, to the extent that a utility is having severe financial difficulties at the time of decommissioning, it may have difficulty in funding an internal reserve when needed for decommissioning. The Commission recognizes that the market value of the stock of those utilities studied in NUREG/CR-3899 has exceeded decommissioning cost. However, although the law in this area is not fully developed, in the event of bankruptcy there is not reasonable assurance that either unsegregated or segregated internal reserves can be effectively protected from claims of creditors and therefore internal reserves cannot be made legally secure. In addition, because of the nature of the internal reserve, the funds collected are not isolated for use for decommissioning. Instead the utility may use the funds for other unrelated purposes.

For the above reasons, the Commission concludes that the internal reserve does not provide reasonable assurance that funds will be available when needed to pay the costs of decommissioning and hence does not provide reasonable assurance that decommissioning will be carried out in a manner which protects public health and safety. Accordingly, the proposed rule has been modified to eliminate the internal reserve as a possible method of providing funds for decommissioning.

In reaching its conclusion not to permit use of internal reserve for decommissioning, the Commission believes it important not to impose inordinate financial burdens on licensees. The modification to the proposed rule is not expected to impose such a burden for several reasons. First, licensees have 2 years from the effective date of the final rule before they have to submit information regarding financial assurance. Second, the external reserve is a sinking fund accumulated over a period of time. Third, a number of states (accounting for almost 50% of power reactors) already require external funding methods. Fourth, recent changes in the tax laws allowing current deductions for external reserves may reduce the cost differential between internal reserve and external reserve.

In summary, NRC has considered the analysis of NUREG/CR-3899, Supp. 1, as well as the documents discussed above. NRC has also considered pertinent factors affecting funding of decommissioning by electric utilities such as the fact that they are regulated entities providing a basic necessity of modern life, their long history of stability, and the situation which may occur in an actual bankruptcy, and the requirements that utilities maintain over one billion dollars of property insurance which reduces one of the major threats to utility solvency. Based on these considerations, it is the Commission's conclusion that the internal reserve method currently allowed by the proposed rule does not provide a reasonable level of assurance of the availability of funds and that even in the unlikely event of utility bankruptcy, there is not reasonable assurance that a reactor will not become a risk to public health and safety.

Whatever funding mechanism is used, its use requires establishing the cost required for decommissioning a facility. This cost should be included as part of financial provisions submitted by an applicant prior to facility commissioning. To minimize administrative effort while still maintaining reasonable assurance of funding, for certain facilities the financial provisions may be based on setting aside an amount which is at least equal to amounts prescribed in the NRC regulations. These amounts vary for the different facilities covered by the regulations.

As information on decommissioning costs become more definitive in time, due to technology improvements, enhanced decommissioning experience, and inflation/deflation cost factors, a licensee's funding provisions should be updated. In this way, it is expected that the decommissioning fund available at the time of facility shutdown will not differ significantly from actual costs of decommissioning.

It is difficult to accurately estimate what the projected costs for the various funding mechanisms will be at the time of decommissioning. Based on Battelle cost analyses[3,11] presented in this EIS, for the generic PWR and BWR 1175 MWe reactors, decommissioning costs have been estimated at approximately $105 and $135 million respectively. These estimates do not include the costs of demolition of nonradioactive systems or structures beyond that necessary to terminate the NRC license or the cost of site restoration. This results in a cost of a few tenths of a mill (0.1 cent) per kilowatt-hour when averaged over the expected 30-year reactor operating life. The $105 million cost, while not insignificant, is only a small amount compared to PWR operating capital, perhaps comparable to the cost of a full core reload. Furthermore, whichever funding mechanism used should not have a significant impact on the cost to consumers. One study[8] has estimated that the difference in cost between the various funding mechanisms would result in less than a 1% difference in the total bill of a representative utility customer.

In summary, the NRC objective of protecting the public health and safety requires that there be reasonable assurance of funds for decommissioning. There should not be any significant financial burden on the applicant in providing a funding mechanism for decommissioning costs either through prepayment, surety bonds, a sinking fund, insurance, or some combination thereof.

2.7 Management of Radioactive Wastes and Interim Storage

During the decommissioning of a nuclear facility radioactive waste which was generated during the facility operating lifetime must be disposed of at waste disposal sites. These wastes include equipment and structures made radioactive both by neutron activation and by radioactive contaminants, include radioactive wastes resulting from chemical decontamination of the facility, and include miscellaneous cleaning equipment.

Disposal of these wastes is covered by existing NRC and other applied Federal and State regulations and is beyond the scope of the rulemaking action supported by the EIS. Disposal of spent fuel will be via geologic repository pursuant to requirements set forth in NRC's regulation 10 CFR Part 60. Disposal of low-level wastes is covered under NRC's regulation 10 CFR Part 61. Because low-level wastes cover a wide range in radionuclide types and activities, 10 CFR Part 61 includes a waste classification system that establishes three classes of waste generally suitable for near-surface disposal: Class A, Class B, and Class C. This classification system provides for successively stricter disposal requirements so that the potential risks from disposal of each class of waste are essentially equivalent to one another. In particular, the classification system limits to safe levels the concentrations of both short- and long-lived radionuclides of concern to low-level waste disposal. The radionuclides considered in the waste classification system of 10 CFR Part 61 include long-lived activation products such as Ni-59 or Nb-94, as well as "intense emitters" such as Co-60.

Wastes exceeding Class C limits are considered to be not generally suitable for near-surface disposal, and those small quantities currently being generated are being safely stored pending development of disposal capacity. The recently enacted Low-Level Radioactive Waste Policy Amendments Act of 1985 (Pub. L. 99-240, approved January 15, 1986, 99 Stat. 1842) provides that disposal of wastes exceeding Class C concentrations is the responsibility of the Federal government. The Act also requires a report by DOE to Congress with recommendations for safe disposal of these wastes. DOE published this report, "Recommendations for Management of Greater than Class C Low-Level Radioactive Waste," DOE/NE-0077, in February 1987.

As far as decommissioning wastes are concerned, technical studies coupled with practical experience from decommissioning of small reactor units indicate that wastes from future decommissionings of large power reactors will have very similar physical and radiological characteristics to those currently being generated from reactor operations. Two of the studies performed by NRC include NUREG/CR-0130, Addendum 3,[3] and NUREG/CR-0672, Addendum 2,[11] which specifically address classification of wastes from decommissioning large pressurized water reactor (PWR) and large boiling water reactor (BWR) nuclear power stations.

These studies indicate that the classification of low-level decommissioning wastes from power reactors will be roughly as shown in Table 2.7-1.

Table 2.7-1 Classification of low-level decommissioning wastes from power reactors

Waste Class	PWR (Vol. %)	BWR (Vol. %)
A	98.0	97.5
B	1.2	2.0
C	0.1	0.3
Above C	0.7	0.2

As shown, the great majority of the waste volume from decommissioning will be classified as Class A waste. Only a small fraction of the wastes will exceed Class C limits.

Transportation of decommissioning wastes will involve no additional technical considerations beyond those for transportation of existing radioactive material. Existing regulations covering transportation of radioactive material are covered under NRC regulations in 10 CFR Parts 20, 71, and 73, and Department of Transportation regulations in 49 CFR Parts 170-189.

An operating 1000 MWe reactor will generate approximately 25.4 MTHM (metric tons of heavy metal) (9.4 m^3) of spent fuel each year and 1300 m^3 of low-level waste each year. When multiplied over the 40-year operating lifetime of the plant, these values can be compared to the 11 m^3 of activated material (greater than Class C) and 17,900 m^3 of low-level waste resulting from DECON of a PWR of similar size (see Section 4.4), and it can be seen that decommissioning will generate an appreciable fraction of the low-level waste generated by a PWR over its lifetime. However, in any given year, the quantity of waste from all operating reactors will considerably exceed that generated from those facilities being decommissioned. The low-level wastes generated in 1980 from commercial nuclear fuel cycle activities totaled 81,000 m^3 and low-level wastes from commercial non-fuel-cycle activities totaled 28,000 m^3. Hence, any problems in waste disposal capacity will be the result primarily of operating nuclear facility waste inputs rather than decommissioning waste inputs. The following is a discussion of the current situation in this area.

Disposal capacity for Class A, Class B, and Class C wastes currently exists. Development of new disposal capacity under the State compacting process is covered under the Low-Level Radioactive Waste Policy Amendments Act referenced above. This Act provides for incentives for development of such capacity, as well as penalties for failure to develop such capacity. For wastes exceeding Class C concentrations, DOE has offered to accept such waste for storage pending development of disposal criteria and capacity. For spent fuel which as noted in Section 2.4 could impact the decommissioning schedule, a detailed schedule for development of monitored retrievable storage and geologic disposal capacity is provided in the Nuclear Waste Policy Act of 1982.

Hence, based on the above discussion, before decommissioning of a nuclear facility occurs, licensees should assess current waste disposal conditions and their potential impact on decommissioning. Although the DECON decommissioning alternative assumes availability of capacity to dispose of waste, alternative methods of decommissioning are available (e.g., SAFSTOR) including delay in completion of decommissioning during which time there can be temporary storage of wastes. Delay in decommissioning can result in a reduction of occupational dose and waste volume due to radioactive decay.

2.8 Safeguards

Just prior to decommissioning, the same safeguards measures may be required that are required while the facility is operating. During the actual decommissioning, levels of special nuclear material in the facility should be decreased as a result of cleanout of the facility. In the case of DECON, decreased levels of safeguards measures should be continued until the quantity of special nuclear material is reduced below safeguards levels, at which time safeguards measures can be discontinued. Regulations defining required procedures and safeguard levels are found in 10 CFR Part 70 Special Nuclear Materials and 10 CFR Part 73 Physical Protection of Plant and Materials. In the case of SAFSTOR, depending on the quantity of special nuclear material as compared to the safeguards levels, continuous manned security may be required or may be replaced by continuous remote monitoring of intrusion, fire, and radiation alarms during the continuing care period. Immediate response is, of course, required in case any alarm is activated. Engineered barriers, such as fences and high-security locks, are maintained and inspected regularly. Deferred decontamination requires similar safeguards provisions as are required during DECON depending on the quantity of special nuclear material remaining at that time. The long-term care period of ENTOMB requires remote monitoring of intrusion, fire, and radiation alarms and engineered barriers if special nuclear material quantities are above safeguard levels.

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10. 50 FR 5600, February 11, 1985.

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*See footnote to reference in Chapter 1 for document purchasing availability.

3 AFFECTED ENVIRONMENT - GENERIC SITE DESCRIPTION

This section describes the characteristics of the sites used as bases for the decommissioning studies of the nuclear facilities discussed in this document. Each facility, with the exception of non-fuel-cycle nuclear facilities, is considered to be located on a reference site. The site described is considered to be representative of the site of a large nuclear installation. Based on the analyses done in Sections 4 through 14 of this EIS, it was found that, while some details may vary from installation to installation, these differences are not expected to have any major impact on the results of the study. The generic fuel cycle facility site is described in Section 3.1.

3.1 Fuel Cycle Facility Site

A reference environment was developed to aid in assessing the public safety and potential environmental effects of decommissioning nuclear facilities by various alternative methods. The meteorology parameters and population distributions were taken from the ALAP Study[1] for a river site in the year 2000. The ecological information was derived from the environment of one operating nuclear reactor.[2] The remainder of the information was obtained from a variety of sources or developed specifically for these studies, and is felt to be representative of potential sites for fuel cycle facilities.

Individual features of any specific nuclear fuel cycle facility will vary slightly from those of a generic site. However, it is believed that use of a generic site will result in a more meaningful overall analysis of potential impacts associated with decommissioning nuclear fuel cycle facilities. Site-specific assessments will be required for the safety analysis and the environmental report submitted with the application for license modification prior to decommissioning a specific facility.

The generic fuel cycle facility site occupies 470 hectares (1160 acres) in a rectangular shape of 2 km (1.24 miles) by 2.35 km (1.46 miles). A moderate sized river runs through one corner of the site. The site is located in a rural area that has relatively low population density. Higher population densities are located at distances of 16 to 64 km (10 to 40 miles), and gradually reducing population densities are encountered out to 177 km (110 miles). The closest moderately large city, population 40,000, is about 32 km (20 miles) distant. The closest large city, population 1,800,000 is about 48 km (30 miles) away. The total population in a radius of 80 km (50 miles) is 3.52 million.

The plant facilities are located inside a 12-hectare (30-acre) fenced portion of the site. The minimum distance from the point of plant airborne releases to the outer site boundary is 1 km. Of the area surrounding the site, about 80% of the land is used for farming.

The relatively clean river flowing through the site has an average flow rate of 1,420 m^3/sec (50,000 ft^3/sec). The river is used for irrigation, fishing, boating and other aquatic recreational activities, and is a source of drinking water for the larger communities. Large supplies of flowing ground water exist at modest depths around the site. This water is widely used for drinking and irrigation.

The reference site occupies a relatively flat terrace that has a low bluff forming one bank of the river. Young soils cover the old basement rocks in the area. This site is in a relatively passive seismic area and is located at an elevation above the estimated maximum probable flood level.

The climate at the site is typical for internal continental areas. It has wide temperature variations and moderate precipitation. Meteorology used in this study is an average taken from 16 nuclear reactor sites.

Less than 20% of the land around the site is covered with pristine vegetation. The original vegetation was primarily a climax deciduous forest. A number of species of migratory birds are present in the area, as well as some annual birds. A number of mammals occupy the general area.

The site is slightly contaminated with radioactive material as a result of deposition from the release of normal operating effluents over the operating lifetime of the facility. It is expected that any accidental releases of radioactive material will be cleaned up immediately following the event. The individual site contamination estimates are based on the predicted normal operating releases of gaseous effluents from the specific type of facility.

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2. U.S. AEC, Final Environmental Statement Related to Operation of Monticello Nuclear Generating Plant, Docket No. 50-263, November 1972, pp. II-15 through II-26.

*See footnote to reference in Chapter 1 for document purchasing availability.

4 PRESSURIZED WATER REACTOR

A pressurized water reactor (PWR) is a facility for converting the thermal energy of a nuclear reaction into steam to drive a turbine-generator and produce electricity. The conversion is accomplished by heating water to a high temperature and pressure in the reactor pressure vessel, using the pressurized hot water to produce steam in the steam generator, and driving the turbine-generator with the steam.

The generic site for the reference 1175-MWe PWR is described in Section 3.1. The specific site for a reactor is chosen on the basis of operational and regulatory criteria, some of which are appropriate to decommissioning as well as to reactor construction and operation. For example, transportation access, water supply, and a skilled labor supply are required for construction and operation, and are also necessary for decommissioning. Usually, however, the most suitable decommissioning alternative will not depend upon the generic site description or upon specific siting considerations. Rather it will depend on such factors as desirability of terminating the license, land use considerations at the time of decommissioning, occupational radiation exposures, and costs. The choice of decommissioning alternative may also depend upon whether or not the facility must be decommissioned before normal retirement age because of premature closure. In any event, the particular alternative chosen will depend almost entirely upon circumstances at the time of decommissioning, rather than upon earlier siting considerations.

Much of what follows is based on the NRC-sponsored Pacific Northwest Laboratory (PNL) studies on the technology, safety and cost of decommissioning a PWR.[1,2] In the parent study,[1] PNL selected the Portland General Electric Company's 1175-MWe Trojan Nuclear Plant at Rainier, Oregon, as the reference PWR and assumed it to be located on a generic site typical of reactor locations. PNL then developed and reported information on the available technology, safety considerations, and probable costs for decommissioning the reference facility at the end of its operating life. Also, as part of an addendum[2] to this study, PNL did a sensitivity analysis to determine the effect that varying certain parameters might have on the conclusions in the original study regarding doses and costs of decommissioning. The parameters that were varied in the addendum included reactor size, degree of radioactive contamination, decommissioning alternatives, etc. The incremental costs of utilizing an external contractor for decommissioning and of additional staff needed to assure that the decommissioning staff do not exceed radiation dose limits have been evaluated in a related follow-on analysis.[3] In another related follow-on study,[4] the estimated decommissioning cost and dose impacts of post-TMI backfit requirements on the reference PWR have been examined and assessed. The results of all of these recent studies are included in the estimated decommissioning cost and dose estimates presented in this chapter for the reference PWR.

4.1 PWR Description

The major components of a PWR are a reactor core and pressure vessel, steam generators, steam turbines, an electric generator, and a steam condenser system

(Figure 4.1-1). Water is heated to a high temperature under pressure inside the reactor and is then pumped in the primary circulation loop to the steam generator. Within the steam generator, water in the secondary circulation loop is converted to steam that drives the turbines. The turbines turn the generator to produce electricity. The steam leaving the turbines is condensed by water in the tertiary loop and returned to the steam generator. The tertiary loop water then flows to cooling towers where it is, in turn, cooled by evaporation. The tertiary loop is open to the atmosphere, but the primary and secondary cooling loops are not.

Buildings or structures associated with the reference PWR include (1) the heavily reinforced concrete containment building, which houses the pressure vessel, the steam generators, and the pressurizer system, (2) the turbine building, which contains the turbines and the generator, (3) the cooling towers, (4) the fuel building, which contains fresh and spent fuel handling facilities, the spent fuel storage pool and its cooling system, and the solid radioactive waste system, (5) the auxiliary building, which contains the liquid radioactive waste treatment systems, the filter and ion exchanger vaults, the gaseous radioactive waste treatment system, and the ventilation systems for the containment, fuel, and auxiliary buildings, (6) the control building, which houses the reactor control room and personnel facilities, (7) water intake structures, (8) the administration building, and (9) perhaps other structures such as warehouses and nonradioactive shops.

In a PWR, the reactor core and its pressure vessel are highly radioactive. So are the steam generators and the piping between the reactor and steam generators. Because the turbines are not directly connected to the primary loop, they are usually not radioactive unless there has been tube leakage in the steam generators. The cooling towers and associated piping are normally not radioactive. Much equipment in the auxiliary building is radioactive, as is the spent fuel storage pool and its associated equipment.

The major radiation problems in decommissioning are associated with the reactor itself, the primary loop, the steam generators, the radioactive waste handling systems, and the concrete biological shield that surrounds the pressure vessel.

4.2 Reactor Decommissioning Experience

At the present time, the Elk River, Minnesota, demonstration reactor is the only power reactor that has been completely dismantled. This was a 58.2-MWt BWR that was dismantled between 1971 and 1974. Though this reactor was quite small compared to present day commercial power reactors, one lesson stands out: reactors can be decontaminated with reasonable occupational radiation exposure and with virtually no public radiation exposure. At Elk River the containment building was kept intact until the pressure vessel and the biological shield were removed. Only after all of the radioactive metal components and concrete areas were removed, was the concrete containment building demolished. Of particular interest was the development of a remotely operated plasma arc torch that was used for cutting 1½-inch-thick stainless steel under water and 3½-inch-thick carbon steel in air.[5] For large reactors, 1,000-MWe, the cutting of $2^3/_4$-inch-thick stainless steel under water and 9-inch-thick carbon steel in air will be required.[6] Based on current technology, this should easily be accomplished.[7,8]

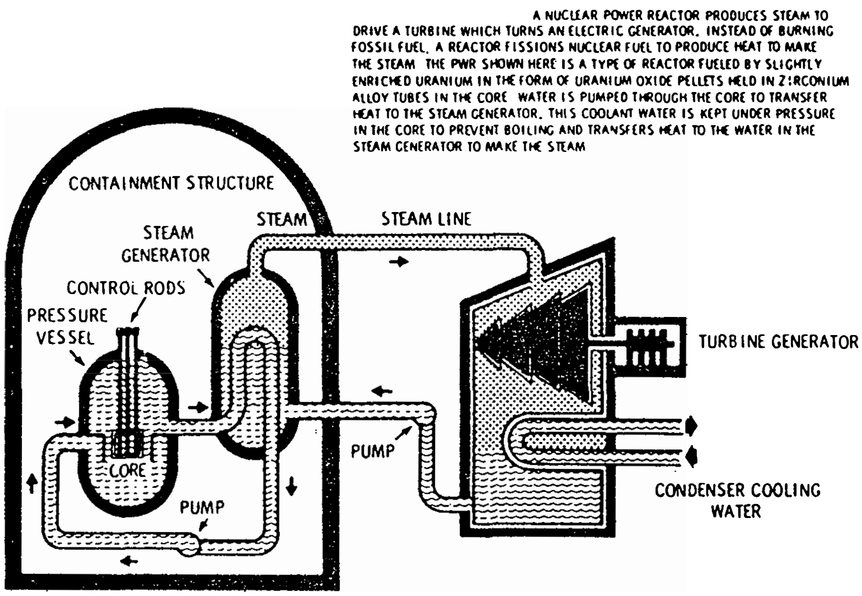

Figure 4.1-1 Pressurized water reactor

Other power reactors, all of them relatively small, have been placed in safe storage or entombed (see Table 1.5-1). These methods of decommissioning require some sort of surveillance as mentioned in Section 2.3, and also require retention of a possession-only license. In the case of the Elk River reactor, its licenses were terminated.

4.3 Decommissioning Alternatives

The decommissioning alternatives considered in this section are DECON, SAFSTOR, and ENTOMB.

4.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use as early as the 6 years estimated for decommissioning after the end of reactor operation.

DECON is advantageous because it allows termination of the NRC license shortly after cessation of facility operations and eliminates a radioactive site. DECON is advantageous if the site is required for other purposes, if the site is extremely valuable, or, if for some reason the site must be immediately released for unrestricted use. It is also advantageous in that the reactor operating staff is available to assist with decommissioning and that continued surveillance and maintenance is not required. A disadvantage is the higher occupational radiation dose which occurs during DECON compared to the other alternatives.

The basic estimates in the original PNL studies have been adjusted by PNL analysts to reflect January 1986 costs. The revised estimate for the reference PWR shows that DECON would require 6 years to complete, including 2 years of planning prior to reactor shutdown, and would cost $88.7 million in 1986 dollars (Table 4.3-1). In addition to the values escalated from the PNL reports (NUREG/CR-0130 and NUREG/CR-0130, Addendum 1), the table also includes the cost additions--for pre-decommissioning engineering, additional staff to assure meeting the 5 rem/year dose limit for personnel, extra supplies for the additional staff, and the additional costs associated with the option of utilizing an external contractor to conduct the decommissioning effort--which were developed in the PNL cost update done for the Electric Power Research Institute.[3] The estimated decommissioning cost impacts of post-TMI-2 requirements on the reference PWR[4] are included in the table as well. It can be seen from the table that the total cost of DECON is about $103.5 million under the utility-plus-contractor option. For comparison purposes, the time required to plan and build a large power reactor is presently about 12 years and the cost is well over two billion dollars.

Three important radiation exposure pathways need to be considered in the evaluation of the radiation safety of normal reactor decommissioning operations: inhalation, ingestion, and external exposure to radioactive materials. For decommissioning workers, external exposure to radioactive materials is the dominant exposure pathway during decommissioning since inhalation and ingestion can be minimized or eliminated as pathways by protective techniques, clothing and breathing apparatus. Inhalation is considered to be the dominant pathway of

Table 4.3-1 Summary of estimated costs for decommissioning the reference PWR in $ Millions [a,b]

Decommissioning Element	DECON[c]	Prep. for Safe Storage[d]	SAFSTOR[e] 10 Years	SAFSTOR[e] 30 Years	SAFSTOR[e] 100 Years	ENTOMB[f] Internals Included (g)	ENTOMB[f] Internals Removed	100 years of Surveillance (h)
Base Case Estimated Decommissioning Costs:								
(1978 dollars)	(31.0)	(9.5)	(39.2)	(40.8)	(39.9)	(21.0)	(24.7)	(3.9)
1986 dollars	73.5					38.2	46.6	6.4
Safe Storage Preparation[d]	NA[1]	17.1	21.8[d]	21.8[d]	21.8[d]	NA	NA	
Continuing Care	NA	NA	1.1	3.7	12.6	(h)	(h)	
Deferred Decontamination[d]	NA	NA	69.4	69.4	40.4	NA	NA	
Possible Additional Costs[j]								
• Additional Staff Needed to Reduce Average Annual Radiation Dose to: 5 rem per year	7.5	1.1				3.1	3.9	
• Use of External Decommissioning Contractor[j]	12.9	4.6				10.5	11.4	
• Pre-Decommissioning Engineering: Internal (utility)[j]	5.6	3.4	4.5	4.5	4.5	5.6	5.6	
or External (contractor)	7.4	4.5				7.4	7.5	
• Supplies for Extra Staff (5 rem/yr average dose)[j]	1.2	0.1				0.6	0.7	
• NRC Licensing Activities[j]	>0.1	~0.1	~0.1[k]	~0.3[k]	~1.0[k]	~0.1	>0.1	~1.0
• Post-TMI-2 Impacts: Internal (utility)[l]	~0.8	negligible[n]	~0.8	~0.8	negligible	~0.3	~0.3	~0.3
or								

Table 4.3-1 (Continued)

Decommissioning Element	DECON[c]	Prep. for Safe Storage[d]	SAFSTOR[e] 10 Years	SAFSTOR[e] 30 Years	SAFSTOR[e] 100 Years	ENTOMB[f] Internals Included (g)	ENTOMB[f] Internals Removed	100 years of Surveillance (h)
External (contractor)[m]	~0.9	negligible				~0.3	~0.3	
Subtotal (<5 rem/yr):								
Utility (Internal) Staffing	88.7	21.8	97.7	100.5	80.3	47.9	57.2	7.4
or								
Contractor (external) Staffing	103.5	27.5				60.2	70.5	7.4
TOTAL Estimated Cost:	88.7		97.7	100.5	80.3			64.6
Utility Staffing	103.5							77.9
or								
Contractor Staffing								

(a) Values include a 25% contingency and are in constant 1986 dollars.

(b) Values exclude cost of disposal of last core, exclude cost of demolition of nonradioactive structures, and exclude cost of deep geologic disposal of dismantled, highly activated components.

(c) Adapted from Reference 1, Table 10.1-1 and Table H.5-2, unless otherwise indicated.

(d) Adapted from Reference 1, Table 2.9-3 and Table H.5-2, unless otherwise indicated.

(e) The values shown for SAFSTOR include the costs of the preparations for safe storage, continuing care, and deferred decontamination.

(f) Adapted from Reference 2, 4.5-1, unless otherwise indicated.

(g) Dose not include the eventual costs associated with the removal, packaging, and disposal of the entombed radioactive materials, the demolition of the entombment structure, or demolition of the Reactor Building.

(h) The annual cost of surveillance and maintenance for the entombed structure is estimated to be about $0.064 million.

(i) NA-not applicable.

(j) Adapted from Reference 3, Table 1.1, unless otherwise indicated.

(k) The values shown include the estimated costs of NRC licensing activities as well as the costs associated with inspections anticipated to be required by other Federal and state agencies.

(l) Adapted from Reference 4, Table 2.5-4.

(m) Adapted from Reference 4, Table 2.5-4 and from Reference 2, Section 6.3.

(n) Negligible means less than $0.025 million.

public radiation exposure, since exposure to radioactive surfaces and ingestion can be minimized or eliminated as radiation pathways to the public during decommissioning. During the transport of radioactive wastes, inhalation and ingestion can be minimized or eliminated as radiation pathways to workers and to the public by techniques similar to those used during decommissioning. Therefore, exposure to radioactive materials is considered to be the dominant mode of radiation exposure to the public and to workers during waste transport. PNL calculated radiation doses for only the dominant pathways, and assumed the radiation doses from other pathways to be essentially zero. A summary of these doses is presented in Table 4.3-2.

The aggregate occupational radiation dose from external exposure to surface contamination and activated material, not including transportation of radioactive waste, is estimated to be about 1115 man-rem over 4 years (Table 4.3-2) or an average of about 279 man-rem per year. The aggregate occupational radiation dose from the transportation of radioactive wastes is estimated to be about 100.2 man-rem to truck transportation workers from DECON waste shipments. For comparison purposes, the average aggregate annual occupational radiation dose from operation, maintenance, and refueling of PWRs from 1974 through 1978 was 550 man-rem per reactor.[9] In 1979 it was 924 man-rems,[10] and in 1980 it was 1,101 man-rems.

This increase is considered to be due to build-up of radioactive contaminants with increasing reactor age[11] and to increasing reactor size[12] and special man-rem intensive maintenance tasks.

The inhalation radiation dose to the public from airborne radionuclide releases during DECON is estimated to be negligible. The radiation dose to the public is calculated to be about 20.6 man-rem from the truck transport of radioactive wastes from DECON.

4.3.2 SAFSTOR

Generally, the purpose of SAFSTOR is to permit ^{60}Co to decay to levels that will reduce occupational radiation exposure during decontamination. As indicated in Table 4.3-2, most of the occupational dose reduction due to decay occurs during the first 30 years after shutdown with considerably less dose reduction thereafter. The public dose, which will always be small, will also experience most of its reduction during the first 30 years. Nonradioactive equipment and structures need not be removed, but eventually all radioactivity in excess of that allowed for unrestricted use of the facility must be removed. Hence, in contrast to DECON, to take advantage of the dose reduction, SAFSTOR could be as long as 60 years including final decontamination. The end result is the same: release of the site and any remaining structures for unrestricted use.

SAFSTOR is advantageous in that it results in reduced occupational radiation exposure in situations where urgent land use considerations do not exist. Disadvantages are that the licensee is required to maintain a possession-only license under 10 CFR Part 50 and to meet its requirements at all times, thus contributing to the number of sites dedicated to radioactive confinement for an extended time period. Other disadvantages are that surveillance is required, the dollar costs are higher than for DECON, and the experienced operating staff may not be available at the end of the safe storage period to assist in the decontamination.

Table 4.3-2 Summary of radiation dose analyses for decommissioning the reference PWR (values are in man-rem)[a,b]

	DECON	SAFSTOR			ENTOMB	
		10 Years	30 Years	100 Years	Internals Included	Internals Removed
Occupational Exposure						
Safe Storage Preparation[c]	NA[j]	282.4[k]	282.4[k]	282.4[k]	NA	NA
Continuing Care[d]	NA	10	14	14	neg.	neg.
Decontamination[e,f]	1,114.5[k]	337.5[k]	24.6[k]	1	NA	NA
Entombment[g]	NA	NA	NA	NA	900	1,000
Safe Stor. Prep. Truck Shipments[h]	NA	10.2	10.2	10.2	NA	NA
Decontamination Truck Shipments[h]	100.2[k]	24.2	1.7	neg.	NA	NA
Entombment Truck Shipments[g]	NA	NA	NA	NA	16	21
Total	1,215[k]	664[k]	333[k]	308[k]	916	1,021
Public Exposure						
Safe Storage Preparation[i]	NA	neg.	neg.	neg.	NA	NA
Continuing Care[i]	NA	neg.	neg.	neg.	neg.	neg.
Decontamination[i]	neg.	neg.	neg.	neg.	NA	NA
Entombment[g]	NA	NA	NA	NA	neg.	neg.
Safe Stor. Prep. Truck Shipments[h]	NA	2.1	2.1	2.1	NA	NA
Decontamination Truck Shipments[h]	20.6[k]	5[k]	0.4	neg.	NA	NA
Entombment Truck Shipments[g]	NA	NA	NA	NA	4	4
Total	21[k]	7[k]	3	2	4	4

Table 4.3-2 (Continued)

[a] All references are from Reference 1, unless otherwise indicated.

[b] Values exclude radiation dose from disposal of the last core.

[c] Table 11.3-2.

[d] Table 11.3-4.

[e] Table 11.3-1.

[f] Table H.6-1.

[g] Tables 3.5-1 and 4.6-1 from Reference 2, with no allowances for radioactive decay (see text for discussion).

[h] Table 11.4-2, with allowances for radioactive decay.

[i] Table 11.2.2.

[j] NA-not applicable.

[k] Values affected by the estimated additional radiation doses due to post-TMI-2 impacts on decommissioning operations. For a detailed explanation of the minor contributions from post-TMI-2 impacts to the total estimates given, consult Table 2.4-1 of Reference 4.

The PNL study shows that the costs of SAFSTOR for a 30-year period are greater than those of DECON and vary with the number of years of safe storage. For example, the total cost of 30-year SAFSTOR is estimated to be $100.5 million in 1986 dollars compared with the total cost of $88.7 million for DECON. However, the total cost of 100-year SAFSTOR is estimated to $80.3 million in 1986 dollars. The lower cost for 100-year SAFSTOR compared to 30-year SAFSTOR is the result of lower costs for deferred decontamination due to the radioactivity having decayed. PNL's cost estimates for the decommissioning alternatives are presented in Table 4.3-1.

SAFSTOR results in lower radiation doses to both the work force and to the public than DECON. The PNL study (Table 4.3-2) shows the aggregate occupational radiation dose to be approximately 321 man-rem for a 30-year SAFSTOR (282.4 man-rem from safe storage preparation, 14 man-rem for continuing care and surveillance, and 24.6 man-rem from deferred decontamination), not including transportation. The occupational radiation dose from the truck transport of radioactive wastes is calculated to be about 12 man-rem. 100-year SAFSTOR results in little additional reduction in the aggregate occupational radiation dose compared to 30-year SAFSTOR.

Radiation doses to the public from airborne radionuclide releases during preparation for safe storage are estimated to be negligible. The radiation dose to the public from the truck transport of radioactive wastes during preparation for safe storage is estimated to be about 2.1 man-rem, and that from the truck transport of radioactive wastes during deferred decontamination after 30 years of safe storage is estimated to be about 0.4 man-rem.

4.3.3 ENTOMB

ENTOMB means the complete isolation of radioactivity from the environment by means of massive concrete and metal barriers until the radioactivity has decayed to levels which permit unrestricted release of the facility. These barriers must prevent the escape of radioactivity and prevent deliberate or inadvertent intrusion. The length of time the integrity of the entombing structure must be maintained depends on the inventory of radioactive nuclides present. A PWR that has been operated only a short time will contain ^{60}Co as the largest contributor to radiation dose and smaller amounts of dominant fission products such as ^{137}Cs with about 30-year half-life. In this case, the integrity of the entombing structure need only be maintained for a few hundred years, as the disappearance of radioactivity is initially controlled by the 5.27-year half-life of ^{60}Co and later by 30-year half-life fission products. If, on the other hand, the reactor has been operated for 30 or 40 years, substantial amounts of ^{59}Ni and ^{94}Nb (80,000-year and 20,000-year half-lives, respectively,) will have been accumulated as activation products in the reactor vessel internals. The dose rate from the ^{94}Nb present in the reactor vessel internals has been estimated to be approximately 2 rem/hour while the dose from the ^{59}Ni in the internals is 0.1 rem/hour. These dose levels are substantially above acceptable residual radioactivity levels and, because of the long half-lifes of ^{94}Nb and ^{59}Ni, would not decrease by an appreciable amount, due to radioactive decay, for thousands of years. In addition, there are an estimated 1,300 curies of ^{59}Ni in the reactor vessel internals which could result in potential internal exposures in the event of a breach of the entombed structure and subsequent introduction of the ^{59}Ni in an exposure pathway during the long half-life of ^{59}Ni. Thus, the long-lived isotopes will have to be removed or the integrity of the entombing structure will have to be maintained for many thousands of years.

ENTOMB of a PWR is limited to the containment building because its unique structure lends itself to entombment and because it contains most of the radioactivity in the facility. The other radioactive buildings associated with a reactor must be decommissioned by another method such as DECON. It is possible, however, to move some radioactive components from the fuel building or auxiliary building to the containment building and entomb them there, rather than ship them offsite.

ENTOMB is advantageous because of reduced occupational and public exposure to radiation compared to DECON, because little surveillance is required, and because little land is required. It is disadvantageous because the integrity of the entombing structure must be assured in some cases for hundreds of thousands of years, because a possession-only license under 10 CFR Part 50 would be required, and because entombing contributes to the number of sites permanently dedicated to radioactive materials containment.

PNL considered two approaches to entombment in an addendum[2] to its earlier PWR study.[1] In both approaches, as much solid radioactive material from the entire facility as can be accommodated is sealed in the containment building beneath the operating floor by means of a continuous concrete slab. All openings to the exterior beneath the operating floor are sealed. Above the operating floor, radioactive materials are removed to sufficiently permit release of that portion of the facility for unrestricted use.

In the first approach, the pressure vessel internals and their long-lived ^{59}Ni and ^{94}Nb isotopes are entombed, along with other radioactive material. This results in less cost and radiation exposure because the pressure vessel and its internals will not have to be removed, dismantled, and transported to a deep geologic waste repository. It will also, however, result in the requirement for a possession-only license and surveillance in perpetuity because of the presence of the long-lived isotopes. Because of the many variables involved, PNL made no firm estimate of the costs for possible deferred dismantlement of the entombment structure. However, these costs are anticipated to be at least of the same order of magnitude as those for deferred dismantlement of the reference PWR after a period of safe storage (see Table 4.3-1).

In the second approach, the pressure vessel internals and their long-lived ^{59}Ni and ^{94}Nb isotopes are removed, dismantled, and transported to a radioactive waste repository (a careful inventory of radioactivity would need to be made to ensure that only relatively short-lived isotopes remained). This approach results in more cost and radiation dose, but offers the possibility that surveillance and the possession-only license could be terminated at some time within several hundred years, thereby releasing the entire facility for unrestricted use.

Radioactive materials not entombed would have to be packaged and transported to a disposal site. Costs and radiation doses for this portion of the entombment procedure would be the same as for DECON. Cost savings and radiation dose reductions result from a lesser volume of radioactive equipment and material having to be dismantled, packaged, and transported. In all cases, spent fuel would be removed.

ENTOMB for the reference PWR, including the pressure vessel and its internals, is estimated to cost $47.9 million, with an annual maintenance cost of $64,000. It results in an aggregate radiation dose of 900 man-rem to decommissioning workers, 16 man-rem to transportation workers, and 4 man-rem to the general public. ENTOMB for the reference PWR, with the pressure vessel internals removed, is estimated to cost $57.2 million with an annual maintenance cost of $64,000, and to result in an aggregate radiation dose of 1000 man-rem to decommissioning workers, 21 man-rem to transportation workers, and 4 man-rem to the general public. These estimates are listed in Tables 4.3-1 and 4.3-2.

Although task-wise schedules were developed for DECON,[1] no comparable schedules were developed for the ENTOMB analysis.[2] As a result, the estimated occupational exposures shown in Table 4.3-2 are not decay-corrected; thus, they represent conservative, upper-bound estimates.

4.3.4 Sensitivity Analyses

An addendum to the initial PNL study was developed[2] to analyze a variety of realistic decommissioning situations that might significantly impact on the original conclusions regarding doses and costs for the various decommissioning alternatives. While there were some differences in results, the conclusion of the sensitivity analysis is that these differences do not substantially affect the original cost and dose conclusions. Of the various situations analyzed by PNL in the addendum, the most important with regard to their potential effect on dose and cost estimates are reactor size and degree of contamination.

Based on an analysis[11] similar to that for the reference PWR (NUREG/CR-0130 Addendum 1) and incorporating selected cost adders (described in References 3 and 4 and escalated to constant 1986 dollars as shown in Table 4.3-1), upper-bound estimates were made of the costs for immediate dismantlement of reactor plants smaller than the reference plant. The analysis was limited to plants with thermal power ratings greater than 1200 MWt and was based on the assumption that all costs (staff labor, equipment, supplies, etc.) except radioactive waste disposal are independent of plant size. The results are shown in Table 4.3-3.

Table 4.3-3 Estimated immediate dismantlement costs for plants smaller than the reference PWR, based on previously-derived overall scaling factors[a,b] (millions of dollars)

Reactor	MWt.	Waste Disposal	Scaling Factor	Remaining Costs	Escalated Adders	Total Costs[(c)]
Trojan	3500	40.223	1.000	34.174	14.385	88.782
Turkey Pt.	2550	40.223	0.789	34.174	14.385	80.295
R. E. Ginna	1300	40.223	0.518	34.174	14.385	69.395

(a) All costs are in constant 1986 dollars and include a 25% contingency.

(b) Derivation of previously-derived overall scaling factors can be found in Reference 2.

(c) Total costs shown above are for the utility-only cost option.

Using the results from Table 4.3-3, a linear equation can be derived for the scaling of the immediate dismantlement costs for plants in the 1200 to 3500 MWt range:

$$\text{Cost} = 57.911 + (8.808 \times 10^{-3})(\text{MWt})$$

Revised overall scaling factors for the Turkey Point and Ginna plants were obtained by dividing the results of the linear equation by the cost of the reference plant. Based on this formula, a list of variations in dose and cost for these PWRs is presented in Table 4.3-4.

The addendum[2] also analyzed the sensitivity of decommissioning costs and radiation doses related to a postulated tripling of radiation dose rates from radionuclides deposited in PWR coolant system piping during reactor operation over a period of 30 to 40 years. This tripling of dose rate is postulated as an upper limit on the basis of recent trends for operating reactors. If no corrective action is taken to reduce the radiation dose rates, the accumulated radiation dose to decommissioning workers for DECON would be increased about 1,250 man-rem[a], and the total decommissioning costs could be increased by about $5.2 million for DECON. For ENTOMB the radiation dose would be nearly doubled and the total cost could be increased about $3.6 million. For preparations for safe storage, the radiation dose would be increased about 130 man-rem, and there would be no significant change in the cost. If corrective action is taken, such as an extended chemical decontamination cycle, the total additional cost could be about $170,000.

In order to handle these postulated higher initial radiation levels, it appears that additional chemical decontamination during decommissioning would be the most cost-effective approach. For example, it is estimated that increasing the circulation time of the chemical solution about 50% would reduce the postulated increased radiation levels by a factor of 3, thus reducing these levels to approximately the same dose rate conditions assumed in the reference case analysis. This approach would also be more consistent with the principles of ALARA, since the occupational radiation dose associated with a chemical decontamination cycle is relatively small, compared with the radiation dose associated with installing temporary shielding, or with attempting to perform the dismantlement without additional shielding. In addition, it appears likely that the large buildups of radionuclides prevalent today on piping systems will be prevented as periodic decontamination during normal operation of the reactor coolant system and related fluid-handling systems become standard procedures when the present technology development for decontamination solutions has been completed.

One of the circumstances that has changed since the original PWR decommissioning reports[1,2] were prepared which could influence the development of the cost and dose estimates presented in this GEIS is an assessment of post-TMI-2 requirements on the decommissioning of the reference PWR. Actions judged necessary by the NRC to correct or improve the regulation and operation of nuclear power plants based on the experience from the accident at TMI-2 resulted in a number of recommendations that were subsequently issued to the utilities as requirements. Some of those requirements resulted in equipment and hardware changes and/or additions to the reference PWR that could eventually expand the

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[a] This number excludes removal of last core and allows for radioactive decay.

Table 4.3-4 Estimated costs and occupational radiation doses for decommissioning different-sized PWR plants[a,b]

		Station		
		R. E. Ginna	Turkey Point	Trojan
Power Rating	(thermal			
Overall Scaling	megawatts)	1.300	2.550	3.500
Factor	(OSF[MWt])	0.781	0.905	1.000
DECON	($ millions)	69.3	80.3	88.7
	(man-rem)	1097.	1.271	1.404
ENTOMB[d]				
w/internals	($ millions)[d]	37.4	43.3	47.9
	(man-rem)	703	815	900
w/o internals	($ millions)	44.7	51.8	57.2
	(man-rem)	781	905	1.000
SAFSTOR				
Preparations for Safe Storage	($ millions)	17.0	19.7	21.8
	(man-rem)	333	386	426
Safe Storage				
for 30 years	($ millions)	3.7	3.7	3.7
	(man-rem)	14	14	14
for 50 years	($ millions)	6.2	6.2	6.2
	(man-rem)	14	14	14
for 100 years	($ millions)	12.6	12.6	12.6
	(man-rem)	14	14	14
Deferred Dismantlement:				
after 30 years	($ million)	54.2	62.8	69.4
	(man-rem)	23.4	27.2	30
after 50 years	($ million)	31.6	36.7	40.5
	(man-rem)	1.9	2.2	2.4
after 100 years	($ million)	31.6	36.6	40.4
	(man-rem)	0.9	1.1	1.2

(a) Values include a 25% contingency and are in 1986 dollars.

(b) Costs do not include spent-fuel disposal or demolition of nonradioactive structures.

(c) Doses are taken from Ref. 2 and do not include transportation doses and do not take credit for radioactive decay during decommissioning.

(d) Entombment costs do not include continuing care cost ($0.064 M/yr.).

scope of decommissioning activities, since those materials could reasonably be expected to become contaminated or radioactive during the remaining operational lifetime of the plant. For the reference PWR, it was concluded by PNL in a recent study[4] that the original immediate dismantlement decommissioning cost estimates could be expected to increase only slightly overall (less than 1% in constant 1986 dollars), due to a slightly expanded scope of decommissioning activities associated with changes in the reference plants characteristics. The radiation dose would be increased by about 32 man-rem, due largely to the dismantling operations associated with the removal of a significantly greater mass of spent fuel pool storage racks.

There are many areas where various planned design and operational features could facilitate decommissioning. Exploration of such areas was considered by PNL[1] in their initial decommissioning study. It was concluded that appropriate measures could not only significantly reduce decommissioning occupational dose and radioactively contaminated waste volume but could also reduce occupational dose during reactor operation. Preliminary considerations of various design and operational features that could further facilitate decommissioning and their impacts on doses and costs are discussed in NUREG/CR-0569.[14]

4.4 Environmental Consequences

Radiation doses and costs associated with possible decommissioning alternatives are discussed in Section 4.3. It is noted for perspective that in the cases of DECON and SAFSTOR, the environmental effects of greatest concern (i.e., radiation dose and radioactivity released to the environment) are substantially less than the same effects resulting from reactor operation and maintenance. It should also be noted that while the dollar costs of ENTOMB are less than those of DECON, the environmental impacts could be quite high should large amounts of radioactivity escape from a breached structure during the entombment period.

Other environmental consequences are rather different from the environmental consequences usually discussed in environmental impact statements. This is because, usually, an environmental impact statement is addressed to the consequences of building a facility that will require land, labor, capital investment, materials, continuing use of air, water, and fuel; a socioeconomic infrastructure; and so on. Decommissioning, on the other hand, is an attempt to restore things to their original condition, which requires a much smaller commitment of resources than did building and operating the facility.

A major environmental consequence of decommissioning, other than radiation dose and dollar cost, is the commitment of land area to the disposal of radioactive waste. PNL made estimates (shown in Table 4.4-1) of the low-level waste disposal volume required to accommodate radioactive waste and rubble removed from the facility and transported to a licensed site for disposal. Reduction in waste volume for SAFSTOR occurs as many of the contamination and activation products present in the facility will have decayed to background levels. The volume for ENTOMB does not include the volume of the entombing structure or of the wastes entombed within it, only the wastes shipped off-site. The entombing structure is, in effect, a new radioactive waste burial ground, separate and distinct from the ones in which the wastes listed in Table 4.4-1 are buried, and may necessitate licensing considerations such as for a low-level waste burial ground under (10 CFR 61).

Table 4.4-1 Estimated burial volume of low-level radioactive waste and rubble for the reference PWR

Decommissioning Alternative		Volume (m^3)
DECON		18,340
SAFSTOR		
Deferred Decontamination[b] following Safe Storage		
for:	10 Years	18,340[a]
	30 Years	18,340[a,c]
	50 Years	1,830
	100 Years	1,780
ENTOMB[d]		1,740

[a] Includes about 440 m^3 of radioactive waste attributable to removal of back-fitted material adapted from Table 5.1-9, Reference 4).

[b] Radioactive wastes from preparation for safe storage and during safe storage are small in comparison to those of deferred decontamination.

[c] Although, in actuality, there is a gradual decrease in waste volume over time, it is not indicated here for clarity of presentation.

[d] Does not include the volume of the entombing structure or of the wastes within.

If shallow-land burial of radioactive wastes in standard trenches is assumed, then a burial volume of 18,340 m^3 of radioactive waste can be accommodated in less than 2 acres. The two acres is small in comparison with the 1,160 acres used as the site of the reference PWR.

Certain highly activated components of the reactor and its internals may require disposal in a deep geologic disposal facility rather than in a shallow-land burial ground because of the large initial level of radioactivity and the very long half-lives of ^{59}Ni and ^{94}Nb. Only about 11 m^3 of material would be involved and would required approximately 88 m^3 of waste disposal space. The cost for disposing of these materials in deep geologic disposal was estimated by PNL to be about $2.8 million (in 1978 dollars).[1] Based on recent estimates of deep geologic disposal costs,[13] it is currently estimated by PNL that deep geologic disposal of the highly activated materials would cost about $6 million (in 1986 dollars). This latter estimate is based on recent estimates of deep geologic disposal costs conducted by Pacific Northwest Laboratory for the Department of Energy.[12] This cost has not been included in the costs of decommissioning shown in Table 4.3-1.

PNL considered accidental releases of radioactivity both during decommissioning and during transport of wastes. Radiation doses to the maximum-exposed individual from accidental airborne radioactivity releases during decommissioning operations were calculated to be quite low (Table 4.4-2). Radiation doses to the maximally-exposed individual from accidental radioactivity releases resulting from truck accidents were calculated to be moderate for the most severe accident (Table 4.4-3).

Other environmental consequences of decommissioning are minor compared to the environmental consequences of building and operating a PWR. Water use and evaporation at the rate of as much as 27×10^6 m^3/yr ceased when the reactor ceased operation. The total water use for decommissioning is estimated to be about 18×10^3 m^3. The number of workers on site at any time will be no greater than when the PWR was in operation and will be much less than when the PWR was under construction. The transportation network is already in place, but will require some maintenance if the SAFSTOR alternative is selected.

Disturbance of the ground cover need not take place to any appreciable extent except for filling holes and leveling the ground following removal of underground structures, unless extended operation of the plant has resulted in contamination of the ground around the plant. Plowing of the ground would generally result in lowering average soil contamination levels to those acceptable for releasing the site for unrestricted use, except for a few more highly contaminated areas where material would have to be removed. In this case, soil to a depth of several centimeters and some paving may have to be removed, packaged, and shipped to a disposal facility before the site can be released for unrestricted use.

The biggest socioeconomic impact will have occurred before decommissioning started, at the time the plant ceased operation and the tax income created by the plant was reduced. No additional public services will be required because the decommissioning staff will be somewhat smaller than the operating staff. In the case of deferred decontamination, the decontamination staff will be larger than the surveillance staff.

4.5 Comparison of Decommissioning Alternatives

From careful examination of Tables 4.3-1 and 4.3-2 it appears that DECON or 30-year SAFSTOR are reasonable options for decommissioning a PWR. 100-year SAFSTOR is not considered a reasonable option since it results in the continued presence of a site dedicated to radioactivity containment for an extended time period with little benefit in aggregate dose reduction compared to 30-year SAFSTOR. DECON costs less than SAFSTOR and its larger annual occupational radiation dose, which is similar to the routine annual dose from plant operations is considered of marginal significance to health and safety.

Either ENTOMB option requires indefinite dedication of the site as a radioactive waste burial ground. In the ENTOMB option with the reactor internals and its long-lived activation products entombed, the security of the site could not be assured for thousands of years necessary for radioactive decay, so this option

Table 4.4-2 Summary of radiation doses to the maximally-exposed individual from accidental airborne radionuclide releases during decommissioning operations

Incident	DECON					Preparations for Safe Storage				
	Airborne Release (μCi)	First-Year Dose (mrem)		Fifty-Year Dose Commitment (mrem)		Airborne Release (mCi)	First-Year Dose (mrem)		Fifty-Year Dose Commitment (mrem)	
		Total Body(a)	Lung	Total Body	Lung		Total Body(a)	Lung	Total Body	Lung
Explosion of LPG Leased from a Front End Loader	3.6×10^{3}	3.6×10^{-2}	4.7×10^{-2}	4.4×10^{-2}	5.4×10^{-2}	---(c)				
Explosion of Oxyacetylene During Segmenting of the Reactor Vessel Shell	3.6×10^{2}	4.3×10^{-5}	6.1×10^{-3}	6.9×10^{-3}	6.9×10^{-3}	---				
Explosion and/or Fire in the Ion Exchange Resin	3.8×10^{1}	3.8×10^{-4}	5.0×10^{-4}	4.6×10^{-4}	5.7×10^{-4}	---				
Gross Leak during In Situ Decontamination	2.1×10^{1}	2.1×10^{-4}	2.8×10^{-4}	2.5×10^{-4}	3.2×10^{-4}	2.1×10^{1}	2.1×10^{-4}	2.8×10^{-4}	2.5×10^{-4}	
Segmentation of RCS Piping With Unremoved Contamination	1.1×10^{1}	4.6×10^{-6}	7.3×10^{-4}	4.8×10^{-6}	7.9×10^{-4}	---				
Loss of Contamination Control Envelope During Oxyacetylene Cutting of the Reactor Vessel Shell	2.3×10^{0}	---	---	---	4.4×10^{-4}	---				
Vacuum Bag Rupture	---					1.0×10^{0}	1.1×10^{-6}	1.3×10^{-5}	1.2×10^{-5}	
Accidental Cutting of Contaminated Piping	---					1.8×10^{-1}	---	1.2×10^{-5}	---	
Accidental Spraying of Concentrated Contamination With the High Pressure Spray	---					1.2×10^{-1}	---	1.6×10^{-6}	1.5×10^{-6}	

(a) The average annual total body dose to an individual in the U.S. from natural sources ranges from 80 to 170 mrem. United Nations Scientific Committee on the Effects of Atomic Radiation, Ionizing Radiation: Levels and Effects. Volume 1, United Nations, pp. 29-63, 1972.

(b) Frequency of occurrence: high $>1.0 \times 10^{-2}$; medium 1.0×10^{-2} to 1.0×10^{-5}; low $<1.0 \times 10^{-5}$ per year.

(c) A dash indicates a dose less than 1.0×10^{-6} mrem or that this action does not apply to the decommissioning mode shown.

Table 4.4-3 Estimated frequencies and radioactivity releases for selected truck transport accidents

Accident Description	Frequency of Accidents per DECON	Frequency of Accidents per SAFSTOR	Release, Curies	Radiation Dose for Maximally Exposed Individual, (rem)(a): 1st Year Dose		50 Yr Dose Commitment	
				Bone	Lung	Bone	Lung
Truck Transport of Decommissioning Wastes[b],[c]							
Minor Accident with Closed Van	8.8×10^{-1}	9.0×10^{-2}	No Release	--	--	--	--
Moderate Accidents with Closed Van	2.1×10^{-1}	2.1×10^{-2}	1×10^{-4}	0.01	0.2	0.01	0.2
Severe Accieent with Closed Van	5.6×10^{-3}	5.7×10^{-4}	1×10^{-2}	1.1	21	1.1	24

[a] Maximally-Exposed individual is assumed at 100 m from the site of the accident.

[b] Based on an inventory of 100 Ci per truck shipment.

[c] Release fractions for respirable material for moderate and severe accidents are assumed to be 10^{-6} and 10^{-4} respectively.

is not considered viable. In the ENTOMB option with the reactor internals removed, it may be possible to release the site for unrestricted use at some time within the order of a hundred years if calculations demonstrate that the radioactive inventory has decayed to acceptable residual levels. However, even this ENTOMB alternative appears to be less desirable than either DECON or SAFSTOR based on consideration of the fact that ENTOMB results in higher radiation exposure and higher initial costs than 30-year SAFSTOR, that the overall cost of ENTOMB over the entombment period is approximately the same as DECON, and the fact that regulatory changes occurring during the long entombment period might result in additional costly decommissioning activity in order to release the facility for unrestricted use.

Consideration was given to the situation where, at the end of the reactor operational life, it is not possible to dispose of waste offsite for a limited period of time, but not exceeding 100 years (see Section 2.7). Such a constraint needs to be accounted for in the decommissioning alternatives. Based on an analysis by PNL of the technology, safety and cost considerations on selection of decommissioning alternatives,[14] it was concluded that SAFSTOR is an acceptably viable alternative. While DECON and conversion of the spent fuel pool to an independent spent fuel storage pool is certainly a possibility for the case where all other radioactive wastes can be removed offsite, there does not appear to be any significant safety difference between this alternative and SAFSTOR and the choice should be a licensee decision. The active phase of maintaining the spent fuel in the pool is not considered to be part of the regulatory requirements for decommissioning, but would be considered under the usual operating licensing aspects regarding health and safety with consideration given to facilitation for decommissioning. Aside from the expenses incurred from storing spent fuel, other costs for keeping radioactive wastes onsite for the reactor in a safe storage mode were estimated to have minimal effect on the SAFSTOR alternative compared to this alternative for radioactive wastes being sent offsite. Site security for storage of spent fuel (which is considered as an operational rather than a decommissioning consideration) was estimated at about \$0.94 million per year (in 1986 dollars)[a]. In a multireactor site, such security could result in less cost because of a sharing of required overheads.

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[a] Adapted from Reference 14.

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5 BOILING WATER REACTOR

A boiling water reactor (BWR), like a pressurized water reactor (PWR), is a facility for converting the thermal energy of a nuclear reaction into the kinetic energy of steam to drive a turbine-generator and produce electricity. In a BWR, the conversion is accomplished by heating water to boiling in the reactor pressure vessel and using the resulting steam to drive the turbines. The intermediate step, present in a PWR, of converting pressurized hot water into steam through a heat exchanger in a steam generator is not used in a BWR. Elimination of this step also eliminates one cooling loop.

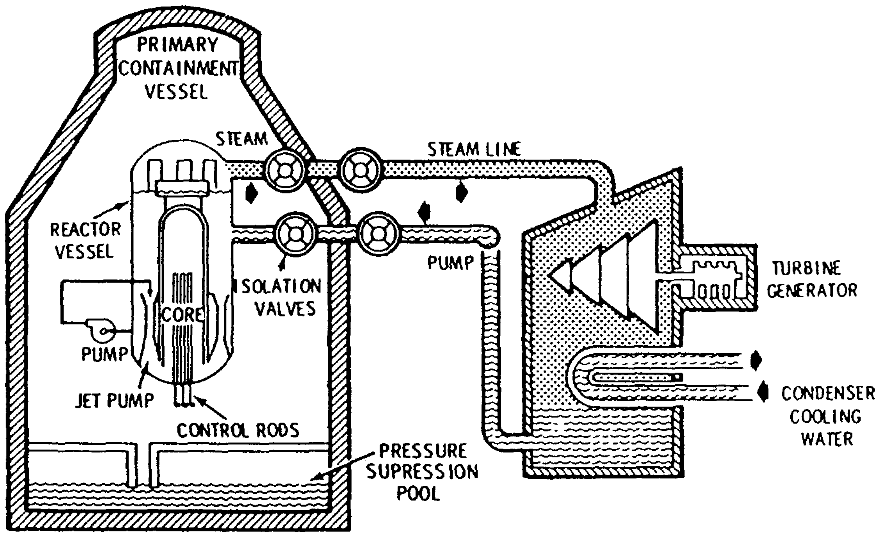
The generic site for the reference 1155-MWe BWR is assumed to be typical of reactor locations and is described in Section 3.1. As in the case of a PWR, the specific site for a BWR is chosen on the basis of operational and regulatory criteria, usually with little regard for decommissioning. Fortunately, factors that are appropriate for siting, such as transportation access, water supply, and skilled labor supply, are also appropriate for decommissioning. Thus, the decommissioning alternative chosen will not usually depend on siting considerations, but rather on safety, costs, and land use options at the time of decommissioning. These considerations are discussed in Section 4 for a PWR, and apply equally to a BWR.

In this section, we have used information prepared for the study on the technology, safety and costs of decommissioning a reference BWR, which was conducted by Pacific Northwest Laboratory (PNL) for the NRC.[1] In the BWR study, PNL selected the Washington Public Power Supply System's WNP-2 1155-MWe reactor at Hanford, Washington, as the reference BWR and assumed it to be located on the generic site. PNL then developed and reported information on the available technology, safety considerations, and probable costs for decommissioning the reference facility at the end of its operating life. As part of this study, PNL did a sensitivity study to analyze the effect that variation of certain parameters might have on radiation doses and costs associated with decommissioning. The parameters which were varied included reactor size, degree of radioactive contamination, different contract arrangements, type of containment structure, etc.

The incremental costs of utilizing an external contractor for decommissioning were updated in a related follow-on analysis.[2] In another related follow-on study,[3] the estimated decommissioning cost and dose impacts of post-TMI-2 requirements on the reference BWR have been examined and assessed. The results of these two recent studies are included in the estimated decommissioning cost and dose estimates presented in this chapter for the reference BWR.

5.1 Boiling Water Reactor Description

The major components of a BWR are a reactor core and pressure vessel, steam turbines, an electric generator, and a steam condenser system (Figure 5.1-1). Water is boiled in the reactor pressure vessel to create steam at high temperature and pressure, which then passes through the primary circulation loop to drive the turbines. The turbines turn the generator, which produces electricity.



A NUCLEAR POWER REACTOR PRODUCES STEAM TO DRIVE A TURBINE WHICH TURNS AN ELECTRIC GENERATOR THE BWR SHOWN HERE IS A TYPE OF REACTOR FUELED BY SLIGHTLY ENRICHED URANIUM IN THE FORM OF URANIUM OXIDE PELLETS HELD IN ZIRCONIUM ALLOY TUBES IN THE CORE. WATER IS PUMPED THROUGH THE CORE, BOILS, AND PRODUCES STEAM THAT IS PIPED TO THE TURBINE.

Figure 5.1-1 Boiling water reactor

The steam leaving the turbines is condensed by water in the secondary loop and flows back to the reactor. The water in the secondary loop flows to the cooling towers where it is in turn cooled by evaporation. The secondary cooling loop is open to the atmosphere, but the primary loop is not.

Buildings or structures associated with the reference BWR include 1) the reactor building which houses the reactor pressure vessel, the containment structure, the biological shield, new and spent fuel pools, and fuel handling equipment; 2) the turbine generator building which houses the turbines and electric generator; 3) the radwaste and control building which houses the solid, liquid, and gaseous radioactive waste treatment systems, and the main control room; 4) the cooling towers; 5) the diesel generator building which houses auxiliary diesel generators; 6) water intake structures and pump houses; 7) the service building which houses the makeup water treatment system, machine shops, and offices; and 8) other minor structures.

In reference BWR, the reactor building, the turbine generator building, and the radwaste building are the only buildings containing radioactive materials. The reactor core and its pressure vessel are highly radioactive, as is the piping to the turbines. The turbines are also radioactive, but the cooling towers and associated piping are not, since the design of the system is such that any leakage would be from the nonradioactive secondary loop to the primary loop. Much equipment in the radwaste building is radioactively contaminated, as is the spent fuel pool in the reactor building.

The major sources of radiation in decommissioning a BWR are associated with the reactor itself, the containment structure, the concrete biological shield, the primary loop, the turbines, and the radwaste handling systems.

5.2 BWR Decommissioning Experience

At the present time, the Elk River, Minnesota, demonstration reactor is the only power reactor that has been completely dismantled.[4] This was a 58.2-MWt BWR that was dismantled between 1971 and 1974. While this reactor was quite small compared to present-day power reactors, its decommissioning served to demonstrate that reactors can be decontaminated safely with little occupational or public risk. At Elk River, the containment building was kept intact until the pressure vessel and biological shield were removed. Only after all of the radioactive metal components and concrete areas were removed was the concrete containment structure demolished.

Other reactors, all of them relatively small, have been placed in safe storage or entombed (Table 1.5-1). Safe storage and entombment require surveillance and retention of a possession-only license. At Elk River, the license was terminated.

5.3 Decommissioning Alternatives

The decommissioning alternatives considered in this section are DECON, SAFSTOR, and ENTOMB.

5.3.1 DECON

DECON means the prompt removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Non-radioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use as early as 6 years after the end of reactor operation.

DECON is advantageous because it allows termination of the NRC license shortly after cessation of facility operations and eliminates a radioactive site. DECON is advantageous if the site is required for other purposes, if the site has become extremely valuable, or if the site for some reason must be immediately released for unrestricted use. It is also advantageous in that the reactor operating staff is available to assist with decommissioning and that continued surveillance and maintenance is not required. A disadvantage is the higher occupational radiation dose which occurs during DECON compared to the other alternatives.

The basic estimates in the original PNL studies have been adjusted by PNL analysts to reflect January 1986 costs. The revised estimate for the reference BWR shows that DECON would require 6 years to complete, including 2 years of planning prior to reactor shutdown, and would cost $108.9 million in 1986 dollars (Table 5.3-1). In addition to the values escalated from the PNL report (NUREG/CR-0672),[1] the table also includes the cost additions--for pre-decommissioning engineering, additional staff to assure meeting the 5 rem/year dose limit for personnel, extra supplies for the additional staff, and the additional costs associated with the option of utilizing an external contractor to conduct the decommissioning effort--which were developed in the PNL cost update done for the Electric Power Research Institute.[2] The estimated decommissioning cost impacts of post-TMI-2 requirements on the reference BWR[3] are included in the table as well. It can be seen from the table that the total cost of DECON is about $131.8 million under the utility-plus-contractor option. For comparison purposes, the time required to plan and build a large power reactor is presently about 12 years and the cost is well over two billion dollars.

Three important radiation exposure pathways need to be considered in the evaluation of the radiation safety of normal reactor decommissioning operations: inhalation, ingestion, and external exposure to radioactive materials. For reasons similar to that discussed for PWRs in Section 4.3.1, during decommissioning the dominant exposure pathway to workers is external exposure while for the public the dominant exposure pathway is inhalation. During the transport of radioactive waste, the dominant exposure pathway is external exposure for both transportation workers and the public. A summary of the radiation doses resulting from these pathways is presented in Table 5.3-2.

The aggregate occupational radiation dose from external exposure to surface contamination and activated material, not including transportation of radioactive waste, is estimated to be about 1764 man-rem over 4 years, or an average of 440 man-rem per year. (Table 5.3-2). The occupational radiation dose to truck transportation workers from DECON waste shipments is estimated to be

Table 5.3-1 Summary of reevaluated decommissioning costs for the reference BWR in $ Millions (a,b)

Decommissioning Element	DECON(c)	Prep. for Safe Storage(d)	SAFSTOR(e) 10 Years	SAFSTOR(e) 30 Years	SAFSTOR(e) 100 Years	ENTOMB(f) Internals Included (g)	ENTOMB(f) Internals Removed	100 years of Surveillance (h)
Base Case Estimated Decommissioning Costs:								
(1978 dollars)	(43.6)	(21.3)	(57.4)	(58.9)	(55.0)	(35.0)	(40.6)	(3.9)
1986 dollars	98.5					68.7	81.4	6.4
Safe Storage Preparation(d)	NA[1]	37.5	41.0	41.0	41.0	NA	NA	
Continuing Care	NA	NA	0.9(j)	3.3(j)	11.6(j)	(h)	(h)	
Deferred Decontamination(d)	NA	NA	82.2	82.2	48.0	NA	NA	
Possible Additional Costs(j)								
• Additional Staff Needed to Reduce Average Annual Radiation Dose to: 5 rem per year	4.4	1.1				2.7	2.3	
• Use of External Decommissioning Contractor(i)	21.1	8.8				17.8	21.3	
• Pre-Decommissioning Engineering: Internal (utility)(l)	5.6	3.4	4.5	4.5	4.5	5.6	5.6	
or External (contractor)	7.4	4.5				7.4	7.5	
• Supplies for Extra Staff (5 rem/yr average dose)(j)	.02	0.1				∼0.1	∼0.1	
• NRC Licensing Activities(m)	>0.1	∼0.1	∼0.1(k)	∼0.3(k)	∼1.0(k)	∼0.1	∼0.1	∼1.0
• Post-TMI-2 Impacts: Internal (utility)(n)	∼0.1	negligible(p)	∼0.1	∼0.1	negligible	∼0.1	∼0.1	∼0.3
or								

Table 5.3-1 (Continued)

Decommissioning Element	DECON[c]	Prep. for Safe Storage[d]	SAFSTOR[e] 10 Years	SAFSTOR[e] 30 Years	SAFSTOR[e] 100 Years	ENTOMB[f] Internals Included (g)	ENTOMB[f] Internals Removed	100 years of Surveillance (h)
External (contractor)[o]	<0.1	negligible				<0.1	<0.1	
Subtotal (<5 rem/yr):								
Utility (Internal)	108.9	41.0	128.3	130.4	106.1	77.3	89.6	7.4
or								
Contractor (external) Staffing	131.8					96.2	112.8	7.4
TOTAL Estimated Cost:								
Utility Staffing	108.9		128.3	131.4	106.1	84.7	97.0	
or								
Contractor Staffing	131.8					104.3	120.2	

TABLE 5.3-1 Footnotes

(a) Values include a 25% contingency and are in constant 1986 dollars.

(b) Values exclude cost of disposal of last core, exclude cost of demolition of nonradioactive structures, and exclude cost of deep geologic disposal of dismantled, highly activated components.

(c) Adapted from Reference 1, Table 10.1-1, unless otherwise indicated.

(d) Adapted from Reference 1, Table 10.2-1, unless otherwise indicated.

(e) The values shown for SAFSTOR include the costs of the preparations for safe storage, continuing care, and deferred decontamination.

(f) Adapted from Reference 1, Table 10.3-1 and Appendix K.

(g) Does not include the eventual costs associated with the removal, packaging, and disposal of the entombed radioactive materials, the demolition of the entombment structure, or demolition of the Reactor Building.

(h) The annual cost of surveillance and maintenance for the entombed structure is estimated to be about $0.064 million.

(i) NA-not applicable.

(j) Adapted from Reference 1, Table 2.10-4.

(k) Adapted from Reference 1, Table J.7-2.

(l) Adapted from Reference 2, Table 1.1, unless otherwise indicated.

(m) The values shown include the estimated costs of NRC licensing activities as well as the costs associated with inspections anticipated to be required by other Federal and state agencies.

(n) Adapted from Reference 3, Table 2.5-7.

(o) Adapted from Reference 3, Table 2.5-7 and from Reference 1, Appendix O.

(p) Negligible means less than $0.025 million.

Table 5.3-2 Summary of radiation dose analyses for decommissioning the reference BWR (values are in man-rem)[a]

		SAFSTOR After			ENTOMB with	
	DECON	10 Years	30 Years	100 Years	Internals Included	Internals Removed
Occupational Exposure						
Safe Storage Preparation	NA[b]	294	294	294	NA	NA
Continuing Care	NA	1	7	10	neg	neg
Decontamination	1764	495	36	neg	NA	NA
Entombment	NA	NA	NA	NA	1492	1603
Safe Stor. Prep. Truck Shipments	NA	22	22	22	NA	NA
Decontamination Truck Shipments	110	22	2	neg	NA	NA
Entombment Truck Shipments	NA	NA	NA	NA	51	69
Total	1874	834	361	326	1543	1672
Public Exposure						
Safe Storage Preparation	NA	neg	neg	neg	NA	NA
Continuing Care	NA	neg	neg	neg	neg	neg
Decontamination	neg	neg	neg	neg	NA	NA
Entombment	NA	NA	NA	NA	neg	neg
Safe Stor. Prep. Truck Shipments	NA	2	2	2	NA	NA
Decontamination Truck Shipments	10	2	neg	neg	NA	NA
Entombment Truck Shipments	NA	NA	NA	NA	5	7
Total	10	4	2	2	5	7

(a) All entries are from Reference 1. Values exclude radiation dose from disposal of last core.

(b) NA means not applicable and neg means negligible.

about 110 man-rem.[a] In comparison, the average annual occupational radiation dose from operation, maintenance, and refueling of BWRs from 1974 through 1979 was approximately 670 man-rem per reactor[5] and 1,136 man-rem in 1980.

The inhalation radiation dose to the public from airborne radionuclide releases during DECON is estimated to be negligible. The radiation dose to the public from the truck transportation of radioactive wastes from DECON is estimated to be about 10 man-rem.

A major reason for the difference in cost and radiation dose between DECON of a BWR and a PWR is the requirement to dismantle, remove, and dispose of the radioactive turbine, condenser, and main steam piping of a BWR. A PWR turbine is not significantly contaminated with radioactivity since the major portion of the radioactivity is confined to the primary coolant systems.

5.3.2 SAFSTOR

Generally, the purpose of SAFSTOR is to permit residual radioactivity to decay to levels that will reduce occupational radiation exposure during subsequent, final decontamination. As indicated in Table 5.3-2, most of the occupational dose reduction due to decay occurs during the first 30 years after shutdown with considerably less dose reduction thereafter. The public dose will always be small and will also experiences most of its reduction during decommissioning within the first 30 years. Nonradioactive equipment and structures need not be removed, but eventually all radioactivity in excess of that allowed for unrestricted use of the facility must be removed. Hence, in contrast to DECON, to take advantage of the dose reduction, the safe storage period could be as long as 60 years including final decontamination. The end result is the same: release of the site and any remaining structures for unrestricted use.

SAFSTOR is advantageous in that it can result in reduced occupational radiation exposure in situations where urgent land use considerations do not exist. Disadvantages are that the owner is required to maintain a possession-only license under 10 CFR Part 50 during the safe storage phase and to meet its requirements at all times, thus contributing to the number of sites dedicated to radioactive materials storage for an extended time period. Other disadvantages are that surveillance and monitoring are required, the cumulative dollar costs are higher than for DECON, and the original operating staff will not be available at the end of the safe storage period to assist in the decontamination.

The PNL study shows that the costs of SAFSTOR for a 30-year period are greater than those of DECON and vary with the number of years of safe storage. For example, the total cost of 30-year SAFSTOR is estimated to be $131.4 million in 1986 dollars compared with the total cost of $108.9 million for DECON.

However, the total cost of 100-year SAFSTOR is estimated to $106.1 million in 1986 dollars. The lower cost of 100-year SAFSTOR compared to 30-year SAFSTOR is the result of lower costs for deferred decontamination due to the radio-

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(a) For a detailed explanation of the minor contributions (e.g., less than 0.08 man-rem for DECON) from post-TMI-2 impacts to the total estimates shown in Table 5.3-2, consult Table 2.4-2 of Reference 3.

activity having decayed. PNL's cost estimates for the decommissioning alternatives are presented in Table 5.3-1.

SAFSTOR results in lower radiation doses to both the work force and the public than DECON or ENTOMB. The aggregate occupational radiation dose is estimated to be approximately 337 man-rem for 30-year SAFSTOR (294 man-rem from safe storage preparation, 7 man-rem from continuing care, and 36 man-rem from deferred decontamination), not including transportation (Table 5.3-2). The occupational radiation dose from the truck transport of radioactive wastes is estimated to be about 24 man-rem. For 100-year SAFSTOR the estimated occupational radiation dose is estimated to be approximately 326 man-rem (294 man-rem from safe storage preparation, 10 man-rem from continuing care, and a negligible dose from deferred decontamination). The occupational radiation dose from the truck transport of radioactive wastes is estimated to be about 22 man-rem. Thus, 100-year SAFSTOR results in little additional reduction in the aggregate occupational radiation dose compared to 30-year SAFSTOR.

Radiation doses to the public from airborne radionuclide releases resulting from SAFSTOR are estimated to be negligible. The radiation dose to the public from the truck transport of radioactive wastes during the preparation for safe storage is estimated to be about 2 man-rem, and that from the truck transport of radioactive wastes during deferred decontamination after 30 and 100 years of safe storage is estimated to be negligible.

5.3.3 ENTOMB

ENTOMB means the complete isolation of radioactivity from the environment by means of massive concrete and metal barriers until the radioactivity has decayed to levels which permit unrestricted release of the facility. These barriers must prevent the escape of radioactivity and prevent deliberate or inadvertent intrusion. The length of time the integrity of the entombing structure must be maintained depends on the inventory of radioactive nuclides present. A BWR will contain ^{60}Co as the largest contributor to radiation dose. If it has been operated only a short time the integrity of the entombing structure need only be maintained for a few hundred years, as the disappearance of radioactivity is controlled by the 5.27-year half-life of ^{60}Co and the 30 year half-life fission products such as ^{137}Cs. If, on the other hand, the reactor has been operated for 30 or 40 years, substantial amounts of ^{59}Ni and ^{94}Nb (80,000-year and 20,000-year half-lives, respectively) will have been accumulated as activation products in the reactor vessel internals. The dose rate from the ^{94}Nb present in the reactor vessel internals has been estimated to be approximately 0.7 rem/hour while the dose from the ^{59}Ni in the internals is 0.07 rem/hour. These dose levels are substantially above acceptable residual radioactivity levels and, because of the long half-lives of ^{94}Nb and ^{59}Ni, would not decrease by an appreciable amount, due to radioactive decay, for thousands of years. In addition, there are an estimated 1,000 curies of ^{59}Ni in the reactor vessel internals which could result in potential internal exposures in the event of a breach of the entombed structure and subsequent introduction of the ^{59}Ni in an exposure pathway during the long half-life of ^{59}Ni. Thus, the long-lived isotopes will have to be removed or the integrity of the entombing structure will have to be maintained for many thousands of years.

ENTOMB for a BWR is limited to the containment vessel because its unique structure lends itself to entombment and because it contains most of the radioactivity in the facility. Other buildings associated with a reactor must be decommissioned by another method such as DECON. It is possible, however, to move some radioactive components from other buildings to the containment vessel and ENTOMB them there, rather than shipping them offsite.

ENTOMB is advantageous because of reduced occupational and public exposure to radiation compared to DECON, because little surveillance is required, and because little land is required. It is disadvantageous because the integrity of the entombing structure must be assured in some cases for hundreds of thousands of years, because a possession-only license under 10 CFR Part 50 would be required which in turn requires some surveillance, monitoring, and maintenance, and because entombing contributes to the number of sites dedicated to radioactive materials containment for very long time periods.

Two approaches to the ENTOMB alternative for a BWR are possible. In the first approach, the pressure vessel internals and their long-lived ^{59}Ni and ^{94}Nb isotopes are entombed, along with other radioactive material. This results in less cost and radiation dose because the pressure vessel and its internals will not have to be removed, dismantled, and transported to a deep geologic waste repository. It will also, however, result in the requirement for a possession-only license and indefinite surveillance because of the presence of the long-lived isotopes.

In the second approach, the pressure vessel internals, with their long-lived ^{59}Ni and ^{94}Nb isotopes, are removed, dismantled, and transported to a radioactive waste repository. This results in more cost and radiation dose, but offers the possibility that surveillance and the possession-only license could be terminated at some time within several hundred years, thereby releasing the entire facility for unrestricted use. At the outset, a careful inventory of radioactivity would need to be made to ensure that only relatively short-lived isotopes were present.

In both approaches, as much solid radioactive material from the entire facility as can be accommodated is sealed within the containment vessel. All openings to the exterior of the containment vessel are sealed. Radioactive material outside the containment vessel is removed down to levels which permit release of the remainder of the facility for unrestricted use.

Radioactive materials not entombed would have to be packaged and transported to a disposal site. Cost savings and radiation dose reductions would result from the lesser volume of radioactive equipment and material having to be dismantled, packaged, and transported. In any case, all spent fuel would be removed.

ENTOMB for the reference BWR, including the pressure vessel and its internals, is estimated to cost $77.3 million, with an annual surveillance and maintenance cost of $64,000. It results in an aggregate radiation dose of 1492 man-rem to decommissioning workers, 51 man-rem to transportation workers, and 5 man-rem to the general public. ENTOMB for the reference BWR, with the pressure vessel internals removed, is estimated to cost $89.6 million, with an annual surveillance and maintenance cost of $64,000, and to result in an aggregate radiation dose of 1603 man-rem to decommissioning workers, 69 man-rem to transportation workers, and 7 man-rem to the general public. These estimates are listed in Tables 5.3-1 and 5.3-2.

5.3.4 Sensitivity Analyses

In addition to the reference BWR, PNL also analyzed a variety of realistic decommissioning situations.[1] These variations were studied to determine if they might have significant impact on the conclusions reached for the reference BWR regarding doses and costs for the decommissioning alternatives. While there were some differences in results, the conclusion of the sensitivity analysis is that these differences do not substantially affect the original cost and radiation dose conclusions. Of the various situations analyzed by PNL, the most important with regard to their potential effect on dose and cost estimates are reactor size, degree of contamination and type of containment structure.

Based on an analysis[6] similar to that for the reference BWR (NUREG/CR-0672) and incorporating selected cost adders (described in References 2 and 3 and escalated to constant 1986 dollars as shown in Table 5.3-1), upper-bound estimates were made of the costs for immediate dismantlement of reactor plants smaller than the reference plant. The analysis was limited to plants with thermal power ratings greater than 1200 MWt and was based on the assumption that all costs (staff labor, equipment, supplies, etc.) except radioactive waste disposal are independent of plant size. The results are shown in Table 5.3-3.

Table 5.3-3 Estimated immediate dismantlement costs (in millions) for plants smaller than the reference BWR, based on previously-derived overall scaling factors[a,b]

Reactor	MWt	Waste Disposal	Scaling Factor	Remaining Costs	Escalated Adders	Total Costs[c]
WNP-2	3320	44.201	1.000	54.464	10.230	108.894
Cooper	2381	44.201	0.809	54.464	10.230	100.453
Vermont Yankee	1593	44.201	0.648	54.465	10.230	93.336

(a) All costs are in constant 1986 dollars and include a 25% contingency.

(b) Derivation of previously-derived overall scaling factors can be found in Reference 1.

(c) Total costs shown above are for the utility-only cost option.

Using the results from Table 5.3-3, a linear equation can be derived for the scaling of the immediate dismantlement costs of plants in the 1200 to 3500 MWt range:

$$\text{Cost} = 78.993 + (9.008 \times 10^{-3})\ (\text{MWt})$$

Revised overall scaling factors for the Cooper and Vermont Yankee plants were obtained by dividing the results of the linear equation by the cost of the reference plant. Based on this formula, a list of variations in dose and cost of these BWRs is presented in Table 5.3-4.

Also analyzed was the sensitivity of decommissioning costs and radiation doses to a postulated tripling of radiation dose rates from radionuclides deposited in BWR coolant system piping during reactor operation over a period of 30 to 40 years. This tripling of dose rate is postulated as an upper limit on the basis of recent trends for operating reactors. If no corrective action is taken to reduce the radiation dose rates, the accumulated radiation dose to decommissioning workers for DECON would be increased from 1764 man-rem to 4573 man-rem,[1] and the total decommissioning costs could be increased by about 12 million for DECON. For ENTOMB the radiation dose would be increased from 1604 man-rem to 4154 man-rem and the total cost could be increased about 12 million. For preparation for safe storage, the radiation dose would be increased from 294 man-rem to 759 man-rem, and there would be no significant change in the cost.

In order to handle these postulated higher initial radiation levels, it appears that additional chemical decontamination during decommissioning would be the most cost-effective approach. For example, it is estimated that increasing the circulation time of the chemical solution about 50% would reduce the postulated increased radiation levels by a factor of 3, thus reducing these levels to approximately the same dose rate conditions assumed in the reference case analysis. This approach would also be more consistent with the principles of ALARA, since the occupational radiation dose associated with a chemical decontamination cycle is relatively small, compared with the radiation dose associated with installing temporary shielding, or with attempting to perform the dismantlement without additional shielding. In addition, it appears likely that the large buildups of radionuclides prevalent today on piping systems will be prevented as periodic decontamination during normal operation of the reactor coolant system and related fluid-handling systems becomes standard procedure.

Analysis was also done to determine if variation in design of the BWR containment structure would have significant impact on doses or costs of decommissioning. There are three principal designs of BWR containments and pressure suppression systems, namely Mark 1, Mark II, and Mark III and these were analyzed by PNL. The conclusion reached by this analysis was that for BWR plants of equivalent power rating, differences in containment design have very little effect on the total cost of decommissioning of a BWR.

One of the circumstances that has changed since the original BWR decommissioning report[1] was prepared which could influence the development of the cost of dose estimates presented in this GEIS is an assessment of post-TMI-2 requirements on the decommissioning of the reference BWR. Actions judged necessary by the NRC to correct or improve the regulation and operation of nuclear power plants based on the experience from the accident at TMI-2 resulted in a number of recommendations that were subsequently issued to the utilities as requirements. Some of those requirements resulted in equipment and hardware changes and/or additions to the reference BWR that could eventually expand the scope of decommissioning activities, since those materials could reasonably be expected to become contaminated or radioactive during the remaining operational lifetime of the plant. For the reference BWR, it was concluded by PNL in a recent study[3] that the original immediate dismantlement decommissioning cost estimates could be expected to increase very slightly overall (considerably less than 1% in

Table 5.3-4 Estimated costs and occupational radiation doses for decommissioning different-sized BWR plants (a, b, c)

		Station		
		Vermont Yankee	Cooper	WNP-2
Power Rating	(thermal megawatts)	1,593	2,381	3,320
Overall Scaling Factor	(OSF)	0.857	0.922	1.000
DECON	($millions)	93.3	100.4	108.9
	(man-rem)	1,581	1,701	1,845(c)
ENTOMB[d]				
w/internals	($ millions)[c]	66.2	71.3	77.3
	(man-rem)	1,348	1,450	1,573
w/o internals	($ millions)	76.8	82.6	89.6
	(man-rem)	1,443	1,553	1,684
SAFSTOR				
Preparations for Safe Storage	($ millions)	35.1	37.8	41.0
	(man-rem)	321	346	375
Safe Storage:				
for 30 years	($ millions)	3.3	3.3	3.3
	(man-rem)	6.5	6.5	6.5
for 50 years	($ millions)	5.6	5.6	5.6
	(man-rem)	10	10	10
for 100 years	($ millions)	11.7	11.7	11.7
	(man-rem)	10	10	10
Deferred Dismantlement:				
after 30 years	($ millions)	70.4	75.8	82.2
	(man-rem)	31	33	36
after 50 years	($ millions)	41.4	44.5	48.3
	(man-rem)	2.6	2.8	3
after 100 years	($ millions)	41.1	44.3	48
	(man-rem)	>1	>1	>1
Facility Demolition	($ millions)	16.4	18.0	19.9

[a] Values include a 25% contingency and are in 1986 dollars.
[b] Costs do not include spent-fuel disposal or demolition of nonradioactive structures.
[c] Doses are taken from Reference 1 and do not include those due to transportation of wastes.
[d] ENTOMB costs do not include continuing care costs (0.064 M/yr).

constant 1986 dollars), due to a slightly expanded scope of decommissioning activities associated with changes in the reference plant's characteristics. The radiation dose would be increased by about 3 man-rem, due entirely to decommissioning operations associated with the removal and packaging of a small additional quantity of contaminated materials.

Other methods of facilitating decommissioning, in addition to additional chemical decontamination, are discussed in NUREG/CR-0569.[7] These include improved documentation, reduction of radwaste volume by incineration, electro-polishing of piping and components as a decontamination technique, remote maintenance and decommissioning equipment (robots), improved access to piping and components, and improved concrete protection.

5.4 Environmental Consequences

Radiation doses and costs associated with possible decommissioning alternatives are discussed in Section 5.3. It is to be emphasized for perspective that for any viable decommissioning alternative, the environmental effects of greatest concern, i.e., radiation dose and radioactivity released to the environment, are substantially less than the same effects resulting from reactor operation and maintenance. It should also be noted that while the dollar costs of ENTOMB are less than those of DECON, the environmental impacts could be quite high should large amounts of radioactivity escape from a breached structure during the entombment period.

Other environmental consequences are rather different from the environmental consequences usually discussed in environmental impact statements. This is because, usually, an environmental impact statement is addressed to the consequences of building a facility that will require land, labor, capital investment, materials, continuing use of air, water and fuel, a socioeconomic infrastructure, etc. Decommissioning, on the other hand, is an attempt to restore things to their original condition, which requires a much smaller commitment of resources than did building and operating the facility.

A major environmental consequence of decommissioning, other than radiation dose and dollar cost, is the commitment of land area to the disposal of radioactive waste. Estimates are shown in Table 5.4-1 of the low-level waste disposal volume required to accommodate radioactive waste and rubble removed from the facility and transported to a licensed site for disposal. The volume for ENTOMB does not include the volume of the entombing structure or of the wastes entombed within it, only the wastes shipped off-site. The entombing structure is, in effect, a new radioactive waste burial ground, separate and distinct from the ones in which the wastes in Table 5.4-1 are buried, and may necessitate licensing consideration such as those for a low-level waste burial ground under (10 CFR 61).

If shallow-land burial of radioactive wastes in standard trenches is assumed, then a burial volume of about 18,975 m^3 of radioactive waste can be accommodated in less than 2 acres. The two acres is small in comparison with the 1,160 acres used as the site of the reference BWR.

Certain highly activated components of the reactor and its internals may require disposal in a deep geologic disposal facility rather than in a shallow-land burial ground because of the large initial level of radioactivity and the very

Table 5.4-1 Estimated burial volume of low-level radioactive waste and rubble for the reference BWR

Decommissioning Alternative	Volume (m^3)
DECON	18,975[a]
SAFSTOR	
Deferred Decontamination[b] following Safe Storage for:	
10 Years	18,975
30 Years	18,975[a,c]
50 Years	1,783
100 Years	1,673
ENTOMB[d]	
Internals Included	8,042
Internals Removed	8,420

[a] Includes about $36 m^3$ of radioactive waste attributable to removal of backfitted material (adapted from Table 5.2-8, Reference 3).

[b] Radioactive wastes from preparations for safe storage are small in comparison to those from deferred decontamination.

[c] Although, in actuality, there is a gradual decrease in waste volume over time, it is not indicated here for clarity of presentation.

[d] Volume of entombing structure and the wastes within are not included.

long half-lives of ^{59}Ni and ^{94}Nb. Only about 11.5 m^3 of material would be involved and would require approximately 89 m^3 of waste disposal space.

The cost for disposing of these materials in deep geologic disposals was estimated by PNL to be about $2.9 million (in 1978 dollars).[1] Based on recent estimates of deep geologic disposal costs,[8] it is currently estimated by PNL that deep geologic disposal of the highly activated materials would cost about 16.2 million (in 1986 dollars). This cost has not been included in the costs of decommissioning shown in Table 5.3-1.

PNL considered accidental releases of radioactivity both during decommissioning during transport of wastes and the results are presented in Table 5.4-2. Radiation doses to the maximally-exposed individual from accidental airborne radioactivity releases during decommissioning operations were calculated to be quite low. Radiation doses to the maximally-exposed individual from accidental radioactivity releases resulting from transportation accidents were calculated to be low for the most severe accident.

Other environmental consequences of decommissioning are minor compared to the environmental consequences of building and operating a BWR. Water use and evaporation at the rate of as much as 27 x 10^6 m^3/yr ceased when the reactor ceased operation. The total water use for decommissioning is estimated to be about 18 x 10^3 m^3. The number of workers on site at any time will be no greater than when the BWR was in operation and will be much less than when the BWR was under construction. The transportation network is already in place, but will require some maintenance if the SAFSTOR mode is selected.

Disturbance of the ground cover need not take place to any appreciable extent except for filling holes and leveling the ground following removal of underground structures, unless operation of the plant has resulted in contamination of the ground around the plant. Plowing of the ground would generally result in lowering average soil contamination levels to those acceptable for releasing the site for unrestricted use, except for a few more highly contaminated areas where materials would have to be removed. In this case, soil to depth of several centimeters and some paving may have to be removed, packaged, and shipped to a disposal facility before the site can be released for unrestricted use.

The biggest socioeconomic impact will have occurred before decommissioning started, at the time the plant ceased operation and the tax income created by the plant was reduced. No additional public services will be required because the decommissioning staff will be somewhat smaller than the operating staff. In the case of deferred decontamination, the decontamination staff will be larger than the surveillance staff.

5.5 Comparison of Decommissioning Alternatives

From careful examination of Tables 5.3-1 and 5.3-2 it appears that DECON or 30-year SAFSTOR are reasonable options for decommissioning a BWR. 100-year SAFSTOR is not considered a reasonable option since it results in the continued presence of a site dedicated to radioactivity containment for an extended time period with little benefit in aggregate dose reduction compared to 30-year SAFSTOR. DECON costs less than SAFSTOR and its larger on an annual basis occupational radiation dose, which is consistent with routine annual operational

Table 5.4-2. Summary of radiation doses to the maximally-exposed individual from accidental airborne radionuclide releases during BWR decommissioning and transportation of wastes

Incident	Total Atmospheric Release (Ci/hr)(b)	Radiation Dose to Lung (in rem) from: DECON First-Year	DECON Fifty-Year	SAFSTOR First-Year	SAFSTOR Fifty-Year	ENTOMB First-Year	ENTOMB Fifty-Year	Occurrence(a)
Severe Transportation Accident	2.0×10^{-2}	9.0×10^{-2}	2.0×10^{-1}	9.0×10^{-2}	2.0×10^{-1}	9.0×10^{-2}	2.0×10^{-1}	Low
Explosion of LPG Leaked from a Front-end Loader	8.6×10^{-3}	7.9×10^{-5}	1.5×10^{-4}	N/Ac	N/A	N/A	N/A	Low
Vacuum Filter-Bag Rupture	8.5×10^{-4}	8.3×10^{-5}	1.8×10^{-4}	8.3×10^{-5}	1.8×10^{-4}	8.3×10^{-5}	1.8×10^{-4}	Medium
Minor Transportation Accident	5.0×10^{-4}	2.2×10^{-3}	4.5×10^{-3}	2.2×10^{-3}	4.5×10^{-3}	2.2×10^{-3}	4.5×10^{-3}	Low
Contamination Control Envelope Rupture	1.4×10^{-4}	1.0×10^{-6}	1.9×10^{-6}	N/A	N/A	N/A	N/A	High
Oxyacetylene Explosion	1.2×10^{-4}	8.7×10^{-7}	1.6×10^{-6}	N/A	N/A	N/A	N/A	Medium
Contaminated Sweeping Compound Fire	1.1×10^{-6}	1.1×10^{-7}	2.3×10^{-7}	1.1×10^{-7}	2.3×10^{-7}	1.1×10^{-7}	2.3×10^{-7}	Medium
Gross Leak During Loop Chemical Decontamination	1.0×10^{-6}	9.8×10^{-8}	2.1×10^{-7}	9.8×10^{-7}	2.1×10^{-7}	9.8×10^{-8}	2.1×10^{-7}	Low
Filter Damage from Blasting Surges	1.3×10^{-7}	1.2×10^{-9}	N/A	N/A	N/A	N/A	N/A	Medium

Table 5.4-2 (Continued)

Incident	Total Atmospheric Release (Ci/hr)(b)	Radiation Dose to Lung (in rem) from: DECON First-Year	DECON Fifty-Year	SAFSTOR First-Year	SAFSTOR Fifty-Year	ENTOMB First-Year	ENTOMB Fifty-Year	Occurrence(a)
Combustible Waste Fire	6.0×10^{-9}	5.9×10^{-10}	1.2×10^{-9}	5.9×10^{-10}	1.2×10^{-9}	5.9×10^{-10}	1.2×10^{-9}	High
Detonation of Unused Explosives	4.8×10^{-10}	4.4×10^{-12}	8.6×10^{-12}	N/A	N/A	N/A	N/A	Medium

(a) The frequency of occurrence considers not only the probability of the accident, but also the probability of an atmospheric release of the calculated magnitude. The frequency of occurrence is listed as "high" if the occurrence of a release of similar or greater magnitude per year is $>10^{-2}$, as "medium" if between 10^{-2} and 10^{-5}, and as "low" if $<10^{-5}$.

(b) All atmospheric releases are assumed to occur during a 1-hr period, for comparison purposes.

(c) N/A = Not applicable.

dose for plant operations is considered of marginal significance to health and safety.

Either ENTOMB option requires indefinite dedication of the site as a radioactive waste burial ground. In the ENTOMB option with the reactor internals and its long-lived activation products entombed, the security of the site could not be assured for thousands of years necessary for radioactive decay, so this option is not considered viable. In the ENTOMB option with the reactor internals removed, it may be possible to release the site for unrestricted use at some time within the order of a hundred years if calculations demonstrate that the radioactive inventory has decayed to acceptable residual levels. However, even this ENTOMB alternative appears to be less desirable than either DECON or SAFSTOR based on consideration of the fact that ENTOMB results in higher radiation exposure and higher initial costs than 30-year SAFSTOR, that the overall cost of ENTOMB over the entombment period is approximately the same as DECON, and the fact that regulatory changes occurring during the long entombment period might result in additional costly decommissioning activity in order to release the facility for unrestricted use.

Consideration was given to the situation where, at the end of the reactor operational life, it is not possible to dispose of waste offsite for a limited period of time, but not exceeding 100 years (see Section 2.7). Such a constraint needs to be accounted for in selecting the decommissioning alternative. Based on an analysis by PNL of the technology, safety and cost considerations on selection of decommissioning alternatives,[9] it was concluded that SAFSTOR is an acceptably viable alternative. Unlike the PWR case, DECON and conversion of the spent fuel pool to an independent spent fuel storage pool for a BWR is an unlikely possibility for the case where all other radioactive wastes can be removed offsite. The active phase of maintaining the spent fuel in the pool is not considered to be part of the regulatory requirements for decommissioning, but would be considered under the usual operating licensing aspects regarding health and safety with consideration given to facilitation for decommissioning. Aside from the expenses incurred from storing spent fuel, other costs for keeping radioactive wastes onsite for the reactor in a safe storage mode were estimated to have minimal effect on the SAFSTOR alternative compared to this alternative for radioactive wastes being sent offsite. Site security for storage of spent fuel (which is considered as an operational rather than a decommissioning consideration) was estimated at about $0.94 million per year (in 1986 dollars)[a]. For a multi-reactor site, such security could result in a lesser cost because of a sharing of required overheads.

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[a] Adapted from Reference 9.

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* See footnote to reference in Chapter 1 for document purchasing availability.

6 MULTIPLE REACTOR STATION

Most of the operating or planned nuclear power reactors in the United States are located at sites with two or more reactors. Twenty-six 2-reactor sites are in operation and an additional nine 2-reactor sites are being constructed. Five 3-reactor sites are in operation. The possibility of locating multiple facilities at a single site is discussed in References 1 through 4. Possibilities range from a small site containing two or three reactors to a very large site with up to 40 reactors and other fuel cycle facilities as well. The 1974 AEC study[1] contemplated up to 40,000 MWe of generating capacity at a single site, together with reprocessing plants, fuel enrichment plants, and waste handling and storage facilities. The 1975 NRC study[2] contemplated power plant centers, fuel cycle centers, and combined centers. The power plant centers would consist of 10 to 40 1200 MWe-capacity nuclear reactors; the fuel cycle centers would include fuel reprocessing plants, mixed oxide fuel fabrication plants, and radioactive waste management facilities; and the combined centers would contain both nuclear power reactors and other fuel cycle facilities. The Hanford Nuclear Energy Center study[3] assumed that 20 to 40 nuclear power plants would be waste management facilities. A Science magazine article[4] examines some of these alternatives and argues for a small number of large sites each containing several reactors, as opposed to a large number of small sites with only one or two reactors at each site.

It is the purpose of this section to investigate whether significant differences in the costs, safety, and other environmental consequences of decommissioning might exist between a reactor at a single-reactor site and one at a multiple-reactor station and whether these differences could have an effect on regulatory considerations. Most of this section is based on a PNL study of the technology, safety and costs of decommissioning nuclear reactors at multiple-reactor stations.[5] In the PNL study, consideration was given to interim storage of waste, permanent onsite disposal of low-level waste, the dedication of the site to nuclear power generation, the availability of centralized services,[a] and the type and number of reactors present at the station. In addition, major facilitation aspects such as modular construction concepts which would allow for intact removal of the reactor pressure vessel during decommissioning were examined.

6.1 Multiple-Reactor Station Description

Although most of the operating or planned nuclear power reactors in the United States are located at stations with two or three reactors, no commercial site presently exists with more than three reactors, and no multiple-reactor sites have been decommissioned. Therefore, it is necessary to develop a model that permits the identification of factors which could affect the cost and safety of decommissioning a nuclear reactor at a site where other reactors are operating, being built, or being decommissioned.

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[a] Central services include health physics services, security forces, solid waste processing, and equipment decontamination services.

6.1.1 Multiple-Reactor Station Concepts

The PNL study[5] identified several variables that could result in differences between the costs and radiation doses anticipated for decommissioning a reactor at a multiple-reactor station and decommissioning an identical reactor at a single-reactor station. These variables include the number of reactors at the multiple-reactor station, the type of reactor, the nuclear waste disposal option, dedication of the site to nuclear power generation, and the provision of central services.

In the PNL study, sites with 4 and 10 reactors were considered. It is more likely that the reactors at a multiple-reactor station with a small number of reactors (i.e., four reactors) will be of the same type and design than it is for a station with a larger number of reactors. However, even at a station with a large number of reactors including both PWRs and BWRs it is probable that there will be several reactors of a given type and design. Standardization of design results in several advantages which can reduce costs and improve safety during the decommissioning of identical reactors at a multiple-reactor station. These advantages include:

- minimizing the planning effort for decommissioning the second and later reactors of an identical or similar design
- improving the productivity of decommissioning workers due to experience gained on the first reactor
- improving the planning of decommissioning techniques and effectively implementing the lessons of past experience.

Nuclear waste disposal is the major contributor to the public radiation dose from decommissioning a nuclear reactor and is a significant item in the decommissioning cost. Decommissioning a reactor at a multiple-reactor station results in the same quantity of nuclear waste for disposal as decommissioning an identical reactor at a single-reactor station. However, options for the management of this waste which may be available at the multiple-reactor station can result in significant cost and radiation dose reductions. To permit release of a site for unrestricted use, the radioactive waste from decommissioning an LWR at a single-reactor station would require disposal at an offsite, licensed nuclear waste disposal facility. However, at a dedicated nuclear site (which remains restricted during dedication), options for the disposal of decommissioning wastes include:

1. disposal at an offsite licensed low-level waste disposal facility
2. interim onsite storage with transfer to an offsite license low-level waste disposal facility at a later date
3. disposal at a permanent onsite low-level nuclear waste disposal facility

Options 2 and 3 generally result in lower costs and smaller occupational and public radiation doses for waste disposal than option 1.[a]

Other cost and safety benefits may result from the location of multiple electric generating facilities at nuclear energy centers. Dedication of a site to nuclear power generation results in replacement reactors being constructed on a schedule to achieve startup of a replacement reactor as an old reactor is shut down and decommissioned. At such dedicated sites, improvements in efficiency as the labor force gains experience and reduction in the planning effort required for decommissioning the second and subsequent reactors of the same or similar types could result in lower decommissioning manpower costs in reduced occupational radiation doses.

A number of onsite, centralized services may be available during decommissioning of a reactor at a multiple-reactor station. The major impact of having centralized services available would be reduction in the cost of decommissioning each reactor.

6.1.2 Multiple-Reactor Station Scenarios

Three multiple-reactor station scenarios are chosen for illustration of the estimated effects of the variables described in Section 6.1.1. Details of the three scenarios are shown in Table 6.1-1. Summaries of estimated cost and occupational and public radiation dose reductions for decommissioning a reactor at a multiple-reactor station relative to decommissioning a reactor at a single-reactor station are given in Section 6.3.

- the site is dedicated to nuclear power generation (i.e., a replacement reactor is started up as each old reactor is shut down)
- central facilities are provided onsite

<u>Scenario III</u>

- the station is large (e.g., ten reactors onsite)
- the four reactors being decommissioned are of the same type
- low-level nuclear waste is permanently disposed of onsite
- the site is dedicated to nuclear power generation (i.e., a replacement reactor is started up as each old reactor is shut down)
- central facilities are provided onsite.

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[a] However, option 3 would necessitate licensing as a low-level waste burial ground under 10 CFR 61 in addition to a possession-only license under 10 CFR 50 for the retired reactor(s).

Table 6.1-1 Multiple-reactor station scenarios

Scenario Number	Number of Reactors of Same Type Decommissioned	Waste Disposal: Immediate Offsite	Waste Disposal: Onsite Interim Storage	Waste Disposal: Onsite Permanent Disposal	Dedicated Site: No	Dedicated Site: Yes	Central Services: No	Central Services: Yes
Single-reactor station	1	X			X		X	
I	2		X		X		X	
II	4		X			X		X
III	4			X		X		X

The three scenarios evaluated for multiple-reactor station decommissioning are:

Scenario I

- the station is small (e.g., four reactors onsite)
- the two reactors being decommissioned are of the same type
- nuclear waste is temporarily stored onsite and moved later to an offsite licensed disposal facility
- the site is not dedicated to nuclear power generation (i.e., a replacement reactor is not started up as each old reactor is shut down)
- central facilities are not provided onsite

Scenario II

- the station is large (e.g., ten reactors onsite)
- the four reactors being decommissioned are of the same type
- nuclear waste is temporarily stored onsite and moved later to an offsite licensed disposal facility

6.1.3 Reference Light Water Reactors

The reference reactors for this analysis of reactor decommissioning at multiple-reactor stations are the same as those described in PNL studies[6,7,8] of the decommissioning of light water reactors at single-reactor power stations. The reference PWR plant is an 1175-MWe (3500-MWt) Westinghouse pressurized water reactor, specifically the Trojan Nuclear Plant at Rainier, Oregon, operated by the Portland General Electric Company. The reference BWR plant is an 1155-MWe (3220-MWt) General Electric boiling water reactor operated by the Washington Public Power Supply System; it is designated as the WPPSS Nuclear Project No. 2 and is located near Richland, Washington. These reactors are also used as bases for the decommissioning cost and safety information presented in Chapters 4 and 5 of this GEIS. A brief description of the reference PWR is given in Section 4.1; a brief description of the reference BWR is given in Section 5.1.

6.2 Multiple-Reactor Station Decommissioning Experience

No multiple-reactor stations containing more than three reactors have been built in the United States, and no multiple-reactor stations have been decommissioned. Therefore, there is no decommissioning history to report. Brief histories of decommissioning individual commercial nuclear power reactors are given in Sections 4.2 and 5.2 of this EIS.

6.3 Multiple-Reactor Station Decommissioning Scenarios

In this section, the costs and radiation doses for decommissioning a reactor at a multiple-reactor station are compared with those for decommissioning an identical reactor at a single-reactor station. The decommissioning alternatives considered are DECON, SAFSTOR, and ENTOMB. Decommissioning costs are summarized in Table 6.3-1 for the reference PWR and in Table 6.3-2 for the reference BWR. Costs are in 1986 dollars and include a 25% contingency. Occupational dose information is summarized in Table 6.3-3 for the reference PWR and in Table 6.3-4 for the reference BWR. Public dose information is summarized in Table 6.3-5 for the reference PWR and in Table 6.3-6 for the reference BWR. The data in these tables are derived from the PNL study[5] on the technology, safety and costs of decommissioning nuclear reactors at multiple-reactor stations and include, where applicable, the costs and doses attributable to nuclear wastes associated with post-TMI-2 backfit requirements (safety upgrades).[9] The bases and assumptions used to estimate decommissioning costs and safety are given in the PNL reports.

Waste disposal options evaluated include: (1) interim onsite storage of waste with later permanent disposal offsite, and (2) permanent onsite disposal. Interim onsite storage would be designed to remotely place the containers of waste in storage cells and remotely remove the containers at the end of the storage period. Onsite storage involves the following tasks:

- packaging
- transporting to interim onsite storage
- placing in interim storage
- retrieving from interim storage
- transporting to a permanent disposal facility
- placing in a permanent disposal facility

Table 6.3-1 Summary of estimated cost reductions when decommissioning each reference PWR at a multiple-reactor station[a]

Cost factor	DECON Cost,[c] $ millions	DECON Cost Reduction $ millions	DECON Cost Reduction percent	SAFSTOR Cost,[c] $ millions	SAFSTOR Cost Reduction $ millions	SAFSTOR Cost Reduction percent	ENTOMB Cost,[c] $ millions	ENTOMB Cost Reduction $ millions	ENTOMB Cost Reduction percent
Waste Disposal[d]									
Immediate Offsite Disposal	40.112	--	--	40.827	--	--	12.609	--	--
Onsite Interim Storage for 30 Years[e]	59.770	(19.658)[f]	(49.0)[f]	37.042	3.785	9.3	13.436	(0.827)	(6.6)
Onsite Interim Storage for 50 Years[e]	37.339	2.773	6.9	36.742	4.085	10.0	10.514	2.095	16.6
Onsite Interim Storage for 100 Years[e]	37.259	2.853	7.1	36.567	4.260	10.4	10.431	2.178	17.3
Immediate Onsite Disposal	32.195	7.917	19.7	32.185	8.642	21.2	6.611	5.998	47.6
Decommissioning Staff Labor[g]									
No. of Reactors of Same Type:									
1	29.183	--	--	31.473	--	--	24.802	--	--
2	26.750	2.433	8.3	28.024	3.449	11.0	22.478	2.324	9.4
4	25.009	4.174	14.3	25.798	5.675	18.0	20.891	3.911	15.8
Central Services[h]									
Without Central Services	9.384	--	--	11.489	--	--	9.384	--	--
With Central Services	4.998	4.386	46.7	5.866	5.623	48.9	4.998	4.386	46.7
Totals for Decommissioning Scenarios[i]									
Single-Reactor Station	88.7	--	--	96.8	--	--	57.2	--	--
Scenario I									
Interim Storage for 30 Years	105.9	(17.2)	(19)	89.6	7.2	7.4	55.7	1.5	3
Interim Storage for 50 Years	83.5	5.2	6	89.3	7.5	7.8	52.8	4.4	8
Interim Storage for 100 Years	83.4	5.3	6	89.1	7.7	8.0	52.7	4.5	8

[a]Summarized from Chapter 8, Appendix A, and Appendix B of Reference 5.

[b]For 30 years safe storage. Values are the sum of the cost of preparations for safe storage plus deferred decontamination.

[c]Costs are in 1986 dollars and include a 25% contingency.

[d]Values exclude the costs of disposal of the last fuel core, exclude cost of demolition of nonradioactive structures and exclude costs of deep geologic disposal of activated components.

[e]Includes the cost of placement in interim storage plus the cost of removal at a later date to permanent offsite disposal.

[f]Parentheses indicate a cost increase.

[g]Values include labor costs for both planning and preparation and decommissioning operations. Security force labor costs are not included.

[h]Central services include health physics services, security services, solid waste processing, and equipment decontamination services.

[i]Multiple-reactor station scenarios are described in detail in Section 6.1.2

Table 6.3-2 Summary of estimated cost reductions when decommissioning each reference BWR at a multiple-reactor station[a]

	DECON			SAFSTOR[d]			ENTOMB		
	Cost,[c]	Cost Reduction		Cost,[c]	Cost Reduction		Cost,[c]	Cost Reduction	
Cost factor	$ millions	$ millions	percent	$ millions	$ millions	percent	$ millions	$ millions	percent
Waste Disposal[d]									
Immediate Offsite Disposal	44.159	--	--	40.159	--	--	25.814	--	--
Onsite Interim Storage for 30 Years[e]	57.703	(13.544)[f]	(30.7)[f]	34.778	9.381	21.2	27.630	(1.816)	(7.0)
Onsite Interim Storage for 50 Years	33.697	10.462	23.7	32.748	11.411	25.8	17.370	8.444	32.7
Onsite Interim Storage for 100 Years[e]	33.335	10.824	24.5	32.359	11.800	26.7	17.030	8.784	34.0
Immediate Onsite Storage	29.633	14.526	32.9	29.500	14.659	33.2	14.063	11.751	45.5
Decommissioning Staff Labor[g]									
No. of Reactors of Same Type:									
1	40.195	--	--	56.443	--	--	38.844	--	--
2	37.216	2.979	7.4	51.940	4.501	8.0	35.906	2.938	7.6
4	34.974	5.221	13.0	48.641	7.800	13.8	33.715	5.129	13.2
Central Services[h]									
Without Central Services	14.512	--	--	20.020	--	--	14.976	--	
With Central Services	8.986	5.526	38.1	12.403	7.617	38.1	9.213	5.763	38.5
Totals for Decommissioning Scenarios[i]									
Single-Reactor Station	108.9	--	--	128.1	--	--	89.6	--	--

Table 6.3-2 (Continued)

Cost factor	DECON Cost,[c] $ millions	DECON Cost Reduction $ millions	DECON Cost Reduction percent	SAFSTOR[d] Cost,[c] $ millions	SAFSTOR Cost Reduction $ millions	SAFSTOR Cost Reduction percent	ENTOMB Cost,[c] $ millions	ENTOMB Cost Reduction $ millions	ENTOMB Cost Reduction percent
Scenario I									
Interim Storage for 30 Years	119.5	(10.6)	(10)	114.2	13.9	11	88.5	1.1	1
Interim Storage for 50 Years	95.5	13.4	12	112.2	15.9	12	78.2	11.4	13
Interim Storage for 100 Years	95.1	13.8	13	111.8	16.3	13	77.9	11.7	13
Scenario II									
Interim Storage for 30 Years	111.7	(2.8)	(3)	103.3	24.8	19	80.5	9.1	10
Interim Storage for 50 Years	87.7	21.2	19	101.1	26.8	21	70.3	19.3	22
Interim Storage for 100 Years	87.3	21.6	20	100.9	27.2	21	69.9	19.7	22
Scenario III	83.6	25.3	23	98.0	30.1	24	67.0	22.6	25

(a) Summarized from Chapter 8, Appendix A, and Appendix B of Reference 5.
(b) For 30 years safe storage. Values are the sum of the cost of preparations for safe storage plus deferred decontamination.
(c) Costs are in 1986 dollars and include a 25% contingency.
(d) Values exclude the costs of disposal of the last fuel core, exclude cost of demolition of nonradioactive structures and exclude cost of deep geological disposal of activated components.
(e) Includes the cost of placement in interim storage plus the cost of removal at a later date to permanent offsite disposal.
(f) Parentheses indicate a cost increase.
(g) Values include labor costs for both planning and preparation and decommissioning operations. Security force labor costs are not included.
(h) Central services include health physics services, security forces, solid waste processing, and equipment decontamination services.
(i) Multiple-reactor station scenarios are described in detail in Section 6.1.2.

Table 6.3-3 Summary of estimated dose reductions when decommissioning each reference PWR at a multiple-reactor station[a]

Dose factor	DECON			SAFSTOR[b]			ENTOMB		
	Occupational Dose,	Occupational Dose Reduction		Occupational Dose,	Occupational Dose Reduction		Occupational Dose,	Occupational Dose Reduction	
	man-rem	man-rem	percent	man-rem	man-rem	percent	man-rem	man-rem	percent
Waste Disposal[d]									
Immediate Offsite Disposal	222.8	--	--	113.9	--	--	64.9	--	--
Onsite Interim Storage for 30 Years[c]	292.0	(69.2)[d]	(31.1)[d]	40.0	73.9	64.9	71.0	(6.1)	(9.4)
Onsite Iterim Storage for 50 Years	150.2	72.6	32.6	36.5	77.4	68.0	53.3	11.6	17.9
Onsite Interim Storage for 100 Years[c]	147.1	75.7	34.0	36.0	77.9	68.4	52.1	12.8	19.7
Immediate Onsite Disposal	132.7	90.1	40.4	27.3	86.6	76.0	45.2	19.7	30.4
Decommissioning Staff Labor									
No. of Reactors of Same Type:									
1	1117	--	--	307	--	--	914	--	--
2	1089	28	2.5	299	8	2.6	891	23	2.5
4	1050	67	6.0	289	18	5.9	859	55	6.0
Solid Waste Processing									
Without Solid Waste Processing	4.4	--	--	1.9	--	--	4.4	--	--
With Solid Waste Processing	0.6	3.8	86.4	0.4	1.5	80.0	0.6	3.8	86.4

Table 6.3-3 (Continued)

Dose factor	DECON			SAFSTOR[b]			ENTOMB		
	Occupational Dose,	Occupational Dose Reduction		Occupational Dose,	Occupational Dose Reduction		Occupational Dose,	Occupational Dose Reduction	
	man-rem	man-rem	percent	man-rem	man-rem	percent	man-rem	man-rem	percent
Totals for Decommissioning Scenarios									
Single-Reactor Station	1477	--	--	558	--	--	979	--	--
Scenario I									
Interim Storage for 30 Years	1518	(41)	(3)	476	82	15	962	17	2
Interim Storage for 50 Years	1376	101	7	472	86	15	944	35	4
Interim Storage for 100 Years	1373	104	7	472	86	15	943	36	4
Scenario II									
Interim Storage for 30 Years	1475	2	<1	465	93	17	930	49	5
Interim Storage for 50 Years	1334	143	10	461	97	17	909	70	7
Interim Storage for 100 Years	1330	147	10	460	98	18	907	72	7
Scenario III	1316	161	11	452	106	19	900	79	8

(a) Summarized from Chapter 9 and Appendix C of Reference 5.
(b) For 30 years safe storage. Values are the sum of doses for preparations for safe storage plus deferred decontamination.
(c) Includes the sum of doses from placement in interim storage, retrieval from interim storage, and placement in permanent offsite disposal, including transportation.
(d) Parentheses indicate a dose increase.

Table 6.3-4 Summary of estimated dose reductions when decommissioning each reference BWR at a multiple-reactor station[a]

Dose factor	DECON Occupational Dose, man-rem	DECON Occupational Dose Reduction man-rem	DECON Occupational Dose Reduction percent	SAFSTOR[b] Occupational Dose, man-rem	SAFSTOR[b] Occupational Dose Reduction man-rem	SAFSTOR[b] Occupational Dose Reduction percent	ENTOMB Occupational Dose, man-rem	ENTOMB Occupational Dose Reduction man-rem	ENTOMB Occupational Dose Reduction percent
Waste Disposal[d]									
Immediate Offsite Disposal	274.3	--	--	128.8	--	--	207.1	--	--
Onsite Interim Storage for 30 Years[c]	297.1	(22.8)[d]	(8.3)[d]	60.8	68.0	52.8	216.1	(9.0)[d]	(4.4)[d]
Onsite Interim Storage for 50 Years	195.2	79.1	28.8	42.3	86.5	67.2	156.9	50.2	24.2
Onsite Interim Storage for 100 Years[c]	190.5	83.8	30.6	41.0	87.8	68.2	153.6	53.5	25.8
Immediate Onsite Disposal	173.7	100.6	36.7	36.3	92.5	71.8	139.7	67.4	32.5
Decommissioning Staff Labor									
No. of Reactors of Same Type:									
1	1767	--	--	331	--	--	1606	--	--
2	1723	44	2.5	323	8	2.4	1566	40	2.5
4	1661	106	6.0	311	20	6.0	1510	96	6.0
Solid Waste Processing									
Without Solid Waste Processing	6.3	--	--	3.3	--	--	6.3	--	--
With Solid Waste Processing	1.3	5.0	79.4	0.8	2.5	75.8	1.3	5.0	79.4

Table 6.3-4 (Continued)

Dose factor	DECON Occupational Dose, man-rem	DECON Occupational Dose Reduction man-rem	DECON Occupational Dose Reduction percent	SAFSTOR[b] Occupational Dose, man-rem	SAFSTOR[b] Occupational Dose Reduction man-rem	SAFSTOR[b] Occupational Dose Reduction percent	ENTOMB Occupational Dose, man-rem	ENTOMB Occupational Dose Reduction man-rem	ENTOMB Occupational Dose Reduction percent
Totals for Decommissioning Scenarios									
Single-Reactor Station	2122	--	--	549	--	--	1894	--	--
Scenario I									
Interim Storage for 30 Years	2101	21	<1	473	76	14	1863	31	2
Interim Storage for 50 Years	1999	123	6	454	95	17	1804	90	5
Interim Storage for 100 Years	1994	128	6	453	96	17	1800	94	5
Scenario II									
Interim Storage for 30 Years	2034	88	4	458	91	17	1802	92	5
Interim Storage for 50 Years	1932	190	9	440	109	20	1743	151	8
Interim Storage for 100 Years	1927	195	9	439	110	20	1739	155	8
Scenario III	1910	212	10	434	115	21	1726	168	9

(a) Summarized from Chapter 9 and Appendix C of Reference 5.
(b) For 30 years safe storage. Values are the sum of doses for preparations for safe storage plus deferred decontamination.
(c) Includes the sum of doses from placement in interim storage, retrieval from interim storage, and placement in permanent offsite disposal, including transportation.
(d) Parentheses indicate a dose increase.

Table 6.3-5 Summary of estimated public dose reductions when decommissioning each reference PWR at a multiple-reactor station[a]

Dose factor	DECON Public Dose, man-rem	DECON Public Dose Reduction man-rem	DECON Public Dose Reduction percent	SAFSTOR[b] Public Dose, man-rem	SAFSTOR[b] Public Dose Reduction man-rem	SAFSTOR[b] Public Dose Reduction percent	ENTOMB Public Dose, man-rem	ENTOMB Public Dose Reduction man-rem	ENTOMB Public Dose Reduction percent
Waste Transportation									
Transport to Immediate Offsite Disposal	20.6	--	--	19.9	--	--	4.5	--	--
Transport to Offsite Disposal After Interim Storage for:									
30 Years	17.9	2.7	13.1	2.4	17.5	87.9	3.4	1.1	24.4
50 Years	3.0	17.6	85.4	1.8	18.1	91.0	1.5	3.0	66.7
100 Years	3.0	17.6	85.4	1.8	18.1	91.0	1.4	3.1	68.9
Transport to Immediate Onsite Disposal	0.0	20.6	100.0	0.0	19.9	100.0	0.0	4.5	100.0
Total Public Dose for Decommissioning Scenarios[(c)]									
Single-Reactor Station	20.6	--	--	19.9	--	--	--	--	--
Scenario I									
Interim Storage for 30 Years	17.9	2.7	13.1	2.4	17.5	87.9	3.4	1.1	24.4
Interim Storage for 50 Years	3.0	17.6	85.4	1.8	18.1	91.0	1.5	3.0	66.7
Interim Storage for 100 Years	3.0	17.6	85.4	1.8	18.1	91.0	1.4	3.1	68.9

Table 6.3-5 (Continued)

Dose factor	DECON Public Dose, man-rem	DECON Public Dose Reduction man-rem	DECON Public Dose Reduction percent	SAFSTOR[b] Public Dose, man-rem	SAFSTOR[b] Public Dose Reduction man-rem	SAFSTOR[b] Public Dose Reduction percent	ENTOMB Public Dose, man-rem	ENTOMB Public Dose Reduction man-rem	ENTOMB Public Dose Reduction percent
Scenario II									
Interim Storage for 30 Years	17.9	2.7	13.1	2.4	17.5	87.9	3.4	1.1	24.4
Interim Storage for 50 Years	3.0	17.6	85.4	1.8	18.1	91.0	1.5	3.0	66.7
Interim Storage for 100 Years	3.0	17.6	85.4	1.8	18.1	91.0	1.4	3.1	68.9
Scenario III	0.0	20.6	100.0	0.0	19.9	100.0	0.0	4.5	100.0

(a) Summarized from Chapter 9 of Reference 5.
(b) For 30 years of safe storage. Values are the sum of doses for preparations for safe storage plus deferred decontamination.
(c) Doses from routine decommissioning operations are estimated to be less than 0.001 man-rem for all decommissioning alternatives. Hence, the dose to the public is estimated to result almost entirely from the transportation of nuclear waste to offsite disposal.

Table 6.3-6 Summary of estimated public dose reductions when decommissioning each reference BWR at a multiple-reactor station[a]

Dose factor	DECON			SAFSTOR[b]			ENTOMB		
	Public Dose, man-rem	Public Dose Reduction man-rem	Public Dose Reduction percent	Public Dose, man-rem	Public Dose Reduction man-rem	Public Dose Reduction percent	Public Dose, man-rem	Public Dose Reduction man-rem	Public Dose Reduction percent
Waste Transportation									
Transport to Immediate Offsite Disposal	22.4	--	--	20.8	--	--	9.6	--	--
Transport to Offsite Disposal After Interim Storage for:									
30 Years	17.0	5.4	24.1	4.1	16.7	80.3	9.2	0.4	4.2
50 Years	3.5	18.9	84.4	1.2	19.6	94.2	2.9	6.7	69.8
100 Years	3.4	19.0	84.8	1.0	19.8	95.2	2.8	6.8	70.8
Transport to Immediate Onsite Disposal	0.0	22.4	100.0	0.0	20.8	100.0	0.0	9.6	100.0
Total Public Dose for Decommissioning Scenarios[c]									
Single-Reactor Station	22.4	--	--	20.8	--	--	9.6	--	--
Scenario I									
Interim Storage for 30 Years	17.0	5.4	24	4.1	16.7	80	9.2	0.4	4
Interim Storage for 50 Years	3.5	18.9	84	1.2	19.6	94	2.9	6.7	70
Interim Storage for 100 Years	3.4	19.0	85	1.0	19.8	95	2.8	6.8	71

Table 6.3-6 (Continued)

Dose factor	DECON			SAFSTOR[b]			ENTOMB		
	Public Dose, man-rem	Public Dose Reduction man-rem	Public Dose Reduction percent	Public Dose, man-rem	Public Dose Reduction man-rem	Public Dose Reduction percent	Public Dose, man-rem	Public Dose Reduction man-rem	Public Dose Reduction percent
Scenario II									
Interim Storage for 30 Years	17.0	5.4	24	4.1	16.7	80	9.2	0.4	4
Interim Storage for 50 Years	3.5	18.9	84	1.2	19.6	94	2.9	6.7	70
Interim Storage for 100 Years	3.4	19.0	85	1.0	19.8	95	2.8	6.8	71
Scenario III	0.0	22.4	100.0	0.0	20.8	100.0	0.0	9.6	100

(a) Summarized from Chapter 9 of Reference 5.
(b) For 30 year of safe storage. Values are the sum of doses for preparations for safe storage plus deferred decontamination.
(c) Doses from routine decommissioning operations are estimated to be less than 0.05 man-rem for all decommissioning alternatives. Hence, the dose to the public is estimated to result almost entirely from the transportation of nuclear waste to offsite disposal.

Because of the necessity of handling each waste package three times, interim onsite storage could result in increased costs and increased occupational exposures unless the waste is stored for a long enough period to result in significant radioactive decay prior to shipment to offsite disposal. The cost and safety of interim onsite storage are evaluated in the PNL study for onsite storage periods of 30, 50, and 100 years.

Sites where large numbers of nuclear power reactors are located conceivably will be large enough to include a permanent onsite low-level nuclear waste disposal facility. Permanent onsite disposal facilities will be operated only at those multiple-reactor stations where the site is not subject to flooding and where the disposal facility can be designed and operated in accordance with the criteria of 10 CFR 61.[10] Any decommissioning wastes that do not meet the criteria on waste classification and waste form given in 10 CFR 61 will be sent offsite to a storage or disposal facility for non-low-level wastes.

It is expected that the efficiency of decommissioning the reactors at a multiple-reactor station will improve after the first reactor is decommissioned due to the learning process. Improved efficiency will result in reduced manpower requirements for decommissioning subsequent reactors of the same type and in reduced labor costs and occupational radiation doses. Cost and dose reductions result from the following factors:

- minimization of the planning effort for decommissioning the second or later reactors of the same type
- standardization and improvement of decommissioning techniques
- stabilization of the work force, resulting in less time spent in learning or rehearsing decommissioning procedures
- improvement of the productivity of decommissioning workers as a result of the learning experience on the first reactor

The PNL study used the following assumptions as bases for estimating reductions in costs and occupational exposures for decommissioning reactors of the same type at a multiple-reactor station:

1. The cost reduction factor for planning and preparation for the second and each succeeding reactor of a particular type (PWR or BWR) is 0.50.

2. The cost and occupational dose reduction factor for decommissioning operations for the second reactor of a particular type is 0.95.

3. The cost and occupational dose reduction factor for decommissioning operations for the third and each succeeding reactor of a particular type is 0.90.

A number of centralized services may be available at a multiple-reactor station, including:

- health physics services
- security forces
- solid waste processing

- equipment decontamination services
- maintenance shops and services
- laundry services
- transportation services
- central stores.

The availability of the first four of these services is estimated to result in significant cost savings for decommissioning. Solid waste processing is also estimated to result in a reduced occupational radiation dose.

Centralized health physics services at a multiple-reactor station could greatly reduce the costs of health physics activities at each reactor, during both the reactor operating life and the decommissioning period following operation. The two major factors postulated to contribute to this cost reduction are:

- the reduced health physics staff overhead at each reactor, resulting from the sharing of certain staff members between several reactors at the site

- the reduced peak-load staffing requirements per reactor, because the large pool of health physics techniques at the site can be shared between reactors as needed

Two factors that account for a reduction in security force costs during decommissioning at a multiple-reactor station are:

- the overhead structure for each reactor can be reduced by sharing certain staff members between reactors

- the off-shift coverage at a reactor being decommissioned can be reduced or eliminated after the spent fuel has been shipped (no special nuclear material at the reactor) if provision is made for routine spot-checks by roving security patrolmen, reducing the overall personnel requirement.

At a multiple-reactor station, a central waste incinerator to serve the whole station can reduce the volume of combustible radioactive waste by about a factor of 25. Therefore, a central waste incinerator can provide significant savings in waste disposal costs and in occupational exposure to transportation workers for both the operating and decommissioning phases of reactor life.

Equipment decontamination services can be more fully utilized at a multiple-reactor station than at a single-reactor station, thereby increasing the economy of these services and the economic incentive to provide improved services and facilities at a multiple-reactor station. Several types of equipment decontamination services are considered to be available at a multiple-reactor station, including:

- decontamination of special tools and equipment used for decommissioning, allowing maintenance and reuse of these items

- mobile decontamination systems for in situ chemical decontamination of piping and components

- central electropolishing and chemical decontamination facilities for improved decontamination of pipe sections and components

In estimating the net reduction in decommissioning costs resulting from the availability of these services, account is taken of the cost of providing the services as well as the cost savings from reuse of equipment. Savings resulting from electropolishing and salvage of stainless steel are two-fold. The material does not require disposal as radioactive waste and the metal can be sold as scrap. However, these cost savings are partially offset by the cost of construction and operation of the central electropolishing facility. At a multiple-reactor station this cost is assumed to be shared by all of the reactors using the facility.

6.3.1 DECON

DECON is the prompt removal and disposal of all materials containing or contaminated with radioactivity in excess of levels permitted for release of the facility for unrestricted use. Under present regulatory requirements, DECON is the only decommissioning alternative that allows termination of the facility license in a short time period. Demolition and removal of decontaminated or uncontaminated structures are not part of DECON, but may be performed at the option of the owner and local government agencies.

The PNL study shows that significant reductions in the cost of DECON may be achievable at a multiple-reactor station. With the exception of 30-year interim onsite storage of the nuclear waste, waste disposal costs are substantially reduced by using either interim onsite storage or permanent onsite disposal of the nuclear waste, compared with immediate offsite disposal. Interim onsite storage for 30 years results in a higher waste disposal cost for both the reference reactors because the 30-year storage period is too short for the radioactivity in the contaminated material to decay to the level at which significant quantities of material can be released. Savings in staff labor costs can be achieved if more than one reactor of the same type is decommissioned due to improvements in the efficiency of decommissioning the second and subsequent reactors of the same type. Significant savings in decommissioning costs are achievable by providing centralized health physics services, centralized security forces, solid waste processing, and decontamination services. While the magnitudes of the cost reductions for DECON, shown in Tables 6.3-1 and 6.3-2, are different for the reference PWR and the reference BWR, the percentage reductions are comparable in most instances.

The total costs of DECON for the reference reactors at multiple-reactor stations are also shown in Tables 6.3-1 and 6.3-2. The multiple-reactor station scenarios are those described in Section 6.1.2. Changes in decommissioning costs are the sums of cost reductions (or cost increases) for the individual cost factors shown in the tables. With the exception of the scenarios that include interim onsite storage of nuclear waste for 30 years, all of the scenarios result in an estimated reduction in the total cost of decommissioning a reactor at a multiple-reactor station. The greatest cost reduction per reactor occurs for Scenario III, which includes immediate onsite disposal of nuclear waste and the decommissioning of four reactors of the same type. For the reference PWR, changes in the total cost (in 1986 dollars) of DECON at a multiple-reactor station range from an increase of about $17.2 million for Scenario I with interim onsite storage for 30 years to a reduction of about $16.5 million for Scenario III. For the reference BWR, changes in the total cost of DECON at a multiple-reactor station range from an increase of about $10.6 million for

Scenario I with interim onsite storage for 30 years to a reduction of about $25.3 million for Scenario III.

The same factors examined in the cost analysis are considered in estimating changes in occupational radiation dose from DECON for a reactor at a multiple-reactor station. With the exception of 30-year interim onsite storage of the nuclear waste from DECON, all of the factors considered result in a reduction in occupational dose. The greatest dose reduction results from immediate onsite disposal of the nuclear waste because of the large reduction in dose to transportation workers. The largest percentage reduction in occupational dose results from solid waste processing. However, the absolute value of this dose reduction is small because the total dose from the packaging of contaminated combustible wastes for shipment is small. For each of the dose factors, the percentage reductions in occupational exposure are about the same for both the PWR and the BWR.

The changes in total occupational dose shown in Tables 6.3-3 and 6.3-4 are the sums of the dose reductions (or dose increases) for the individual dose factors shown in the tables. With the exception of multiple-reactor station scenarios that involve interim onsite storage of nuclear waste for 30 years, the total occupational dose from DECON at a reactor at a multiple-reactor station is estimated to be smaller than that from DECON at a single-reactor station. For the reference PWR, changes in the total occupational dose from DECON for a reactor at a multiple-reactor station range from an increase of about 41 man-rem for Scenario I with interim onsite storage for 30 years to a reduction of about 161 man-rem for Scenario III. For the reference BWR, changes in the total occupational dose from DECON at a multiple-reactor station range from a decrease of about 21 man-rem for Scenario I with interim onsite storage for 30 years to a reduction of about 212 man-rem for Scenario III.

As shown in the reference PNL studies[6,7,8] on the decommissioning of nuclear reactors at single-reactor stations, the public dose from normal decommissioning activities is small and comes principally from the transportation of nuclear wastes to a licensed offsite disposal facility. Interim onsite storage of the nuclear waste from decommissioning can significantly reduce this already small public radiation dose, especially if the onsite storage period is 50 to 100 years. Permanent onsite disposal of the nuclear waste from decommissioning reduces the dose to the public from waste transportation activities to zero.

6.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place a reactor in a condition that poses an acceptable risk to the public (preparations for safe storage) and safely stores the property for as long as desired to allow decay of some of the radioactivity, followed by decontamination of the facility to levels which permit release of the facility for unrestricted use (deferred decontamination). As shown previously in Chapter 4 and Chapter 5, SAFSTOR results in greatly reduced occupational radiation doses because decommissioning activities that must be performed immediately after reactor shutdown when radiation exposure levels are high are kept to a minimum, and the major decommissioning activities (deferred decontamination activities) take place after ^{60}Co has decayed to levels that result in significantly reduced radiation dose rates. SAFSTOR may be used to advantage at a multiple-reactor station where there is less incentive to decontaminate a reactor to unrestricted use levels immediately following shutdown.

One of the principal disadvantages of SAFSTOR, namely that personnel familiar with the construction and operation of the plant may not be available at the end of the safe storage period to assist in deferred decontamination, may be less of a problem at a multiple-reactor station than at a single-reactor station. Personnel would normally be available onsite at a multiple-reactor station who have similar construction and operating experience, even though they might not be intimately familiar with the plant currently being decommissioned.

The information in Tables 6.3-1 through 6.3-6 on cost and dose reductions for the SAFSTOR alternative assumes a safe storage period (the period following reactor shutdown until deferred decontamination takes place) of 30 years. Information on cost and dose reductions for SAFSTOR at multiple-reactor stations with 50- and 100-year safe storage periods is presented in the PNL study[5] on which this chapter is based. In general, the cost and radiation dose reductions for interim onsite storage or onsite disposal of nuclear waste are not as great following safe storage periods of 50 or 100 years as they are following a safe storage period of 30 years. This is because the radioactive decay associated with the 50- and 100-year safe storage periods results in waste management requirements which are already significantly reduced from what would be required for offsite disposal of the waste immediately following reactor shutdown.

The cost and occupational dose values for 30-year SAFSTOR presented in Tables 6.3-1 through 6.3-4 are the sum of values for preparations for safe storage plus deferred decontamination. In general, the estimated percentage decreases in decommissioning costs for multiple-reactor station decommissioning are approximately the same for 30-year SAFSTOR as they are for DECON. The estimated percentage decreases in occupational dose for multiple-reactor station decommissioning are approximately twice as large for 30-year SAFSTOR as they are for DECON. An exception is the case of onsite interim storage of nuclear waste for 30 years which is estimated to result in cost and dose increases for DECON but in cost and dose decreases for 30-year SAFSTOR. The decreases for SAFSTOR result from the fact that a major portion of the decommissioning waste from this alternative is generated during deferred decontamination, and the 30-year safe storage period followed by 30 years of onsite storage results in significant radioactive decay and in reduced disposal requirements.

As in the case for DECON, radiation dose to the public from SAFSTOR results almost entirely from the transportation of nuclear waste to on offsite licensed disposal facility. Interim onsite storage of the nuclear waste from SAFSTOR results in a significantly reduced public dose from waste transportation activities, and permanent onsite disposal of the waste reduces this dose to zero.

6.3.3 ENTOMB

ENTOMB is the encasement and maintenance of the nonreleasable radioactive materials in a monolithic structure to ensure complete isolation of the radionuclides from the environment until the radioactivity has decayed to levels which permit release of the facility for unrestricted use.

Two approaches to ENTOMB are possible: 1) the reactor vessel internals, which have extremely long-lived radioactivity, are removed and shipped to a nuclear waste repository, and 2) the reactor vessel internals are left in place. In each case, as much of the contaminated equipment from outside the entombment structure as can be stored in the entombment structure is moved there. In the first case, because of the relatively short half-lives of the entombed radioactivity, it may be possible, without dismantling the structure, to terminate the amended nuclear license and release the entombment structure for unrestricted use after a continuing care period of about 100 years. (However, present regulatory guidance does not allow such action without a comprehensive survey to establish that radioactive contamination is within acceptable release limits.) In the second case, existing regulations require the amended nuclear license to remain in force for an indefinite period of continuing care, unless the reactor vessel internals are removed at a later date.

When it becomes desirable to terminate the amended nuclear license for ENTOMB, dismantling of the entombment structure may be required for the second approach. This represents a task that is much more difficult than dismantling the unentombed facility, since the entombment structure is built to endure for a long period of time. Therefore, the second approach to ENTOMB, and perhaps the first approach also, must be viewed as an almost irreversible commitment to long-term maintenance of the nuclear license. (However, dismantlement of the entombment structure is not impossible, only very difficult.) Based on the above considerations, the second approach to ENTOMB, and perhaps the first approach also, must be viewed as relatively unattractive decommissioning alternatives for a multiple-reactor station.

The cost and dose information presented in Tables 6.3-1 through 6.3-6 are based on the first approach to ENTOMB (removal of the reactor vessel internals prior to entombment). On a percentage basis, cost and dose reductions from ENTOMB for a reactor at a multiple-reactor station are estimated to be comparable to cost and dose reductions from DECON. The radiation dose to the public is significantly reduced for interim onsite storage of radioactive wastes followed by later disposal at a licensed offsite facility, and is reduced to near zero for confinement of wastes to the site (multiple-reactor station Scenario III).

6.4 Environmental Consequences

As shown in Sections 4.3 and 5.3, the greatest radiological impact to the public from decommissioning of a nuclear power reactor is the possible radiation dose from truck shipment of the nuclear waste to a shallow-land disposal site. At a multiple-reactor site, interim storage of the waste to permit radioactive decay or permanent onsite disposal would reduce or eliminate the already small dose to the public from transportation of the decommissioning wastes. Releases of radioactivity to water during decommissioning will be negligible, as in the case of facilities on single-station sites. Impacts to the public from releases of radioactivity to the air will be less than in the case of single-reactor sites. This is because the public will be, on the average, farther away from each reactor because of the large area occupied by a multiple-reactor station.

Radiological impacts to transportation workers will be less then they would be if the wastes were immediately transported to an offsite disposal location. However, for interim onsite storage of the wastes, the total radiation dose to workers who must handle the wastes during emplacement and retrieval operations would increase. The possibility is excellent that the radiation dose to decommissioning workers can be reduced because of the experience gained from the repetition of the decommissioning process.

Waste disposal at a site dedicated for nuclear power generation would require approximately 1 km^2 of land to be used for a shallow-land burial ground. Approximately 10% of the burial ground area is estimated to be required for the storage or disposal of decommissioning wastes. Appropriate control of inventory and site will allow for unrestricted release in several hundred years following shallow-land burial.[10,11] Radioactive wastes that would require longer time periods to achieve unrestricted release are assumed to be placed in appropriate intermediate-depth burial grounds as per 10 CFR Part 61 either onsite or in a deep geologic repository offsite.

A major socioeconomic impact will occur at the time construction of the last reactor is completed at a dedicated multiple-reactor station. If decommissioning has proceeded as older reactors are retired from service, decommissioning crews will already be on site and construction crews will be discharged when construction is completed. Decommissioning of the final reactors retired from service will be performed by personnel who have operated these reactors. Following decommissioning of the last reactor, only a minimal crew will be required for surveillance of reactors that are being maintained in safe storage and to provide surveillance activities for the radioactive waste buried onsite.

6.5 Comparisons of Reactor Decommissioning at Multiple-Reactor Stations and at Single-Reactor Stations

Based on the information presented in Section 6.3 and in Tables 6.3-1 through 6.3-6, the following conclusions may be drawn with regard to the cost and safety of decommissioning a nuclear power reactor at a multiple-reactor station.

1. Decommissioning of a light-water reactor at a multiple-reactor station probably will be less costly and result in lower occupational radiation doses than decommissioning of an identical reactor at a single-reactor station. The option of onsite storage or disposal of the nuclear waste at a multiple-reactor station has the potential of reducing the public radiation dose from reactor decommissioning to near zero.

2. Although the magnitudes of the decommissioning costs and occupational radiation doses are less, the relative standing of the costs and doses for the three decommissioning alternatives is not changed at the multiple-reactor station compared to a single-reactor station. SAFSTOR results in the lowest occupational radiation dose but generally has the highest costs (in constant dollars). ENTOMB, if the reactor can be released for unrestricted use after 100 years of surveillance, is estimated to have the lowest cost. DECON is estimated to have the highest radiation dose and an intermediate decommissioning cost.

3. Decommissioning costs and occupational radiation doses for the two types of reactors (PWR and BWR) are affected in about the same way by the factors studied at multiple-reactor stations. In determining if there is a cost or dose advantage for decommissioning nuclear reactors at a multiple-reactor station versus a single-reactor station, the type of reactor (PWR or BWR) has little influence on the result.

4. All the factors investigated in the PNL study[5]--interim onsite nuclear waste storage, permanent onsite waste disposal, dedication of the site to nuclear power generation, and provision of centralized services--can contribute to reduced decommissioning costs and occupational doses. The number of reactors at a multiple-reactor station may influence the availability of onsite storage, site dedication, and centralized services.

5. The possibility of onsite interim storage or of permanent onsite disposal of decommissioning wastes at a multiple-reactor station could facilitate reactor decommissioning in the event of the unavailability of facilities for the offsite disposal of low-level radioactive wastes.

One of the alternatives for reactor retirement is conversion to a new nuclear- or fossil-fueled steam supply system. Reuse of the facilities at a nuclear power station that can be refurbished makes good economic sense. Capital cost studies of PWRs[11] and BWRs[12] have shown that the structures and equipment other than the nuclear steam supply system account for about 70% of the initial direct construction cost. At a multiple-reactor station dedicated to nuclear power generation, conversion of a retired reactor to a new nuclear-fueled steam supply system may be particularly advantageous.

Analyses of removing the old reactor vessel intact from a retired PWR or BWR and replacing it with a new vessel indicate that such action is feasible, but difficult. Examples of design features that could be incorporated in a light-water reactor to facilitate the later removal or replacement of the reactor pressure vessel and other large equipment pieces include:

- an equipment hatch in the reactor containment building large enough to accommodate the intact reactor pressure vessel

- an equipment hatch located so that there is sufficient lay-down area, both in the containment building and in any adjoining building, to line up the reactor vessel with the hatch

- adequate supports in the reactor building to handle the special cranes needed for very heavy loads such as the reactor pressure vessel and steam generators

- a readily removable roof section in the fuel building of a PWR and in the reactor building of a BWR large enough to accommodate the reactor pressure vessel

- an inner shield of modular design that can be removed and/or replaced.

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*See footnote to reference in Chapter 1 for document purchasing availability.

7 RESEARCH AND TEST REACTORS

A research reactor is defined in 10 CFR 170.3(h)[1] as a nuclear reactor licensed for operation at a thermal power level of 10 megawatts or less, and which is not a testing facility. A testing facility (i.e., a test reactor) is defined in 10 CFR 50.2 as a nuclear reactor licensed for operation at: 1) a thermal power level in excess of 10 megawatts, or 2) a thermal power level in excess of 1 megawatt if the reactor is to contain: a circulating loop through the core in which the applicant proposes to conduct fuel experiments, or a liquid fuel loading, or an experimental facility in the core in excess of 16 square inches in cross-section. There are 84 nonpower research and test (R&T) reactors in the U.S. that are licensed by the NRC. Of these 76 are research reactors, and 8 are test reactors. The level of activity of these facilities ranges from no longer operational, to occasional use, to intermittent use, to steady and scheduled use.

Because of the diversity in types and sizes of R&T reactor facilities and in the operational schedules and lifetimes associated with them, the level of effort required to decommission them varies greatly. Necessary actions can range from simple, relatively inexpensive decommissioning activities and administrative procedures to extensive decontamination and disposal activities costing millions of dollars. This section presents an assessment of the environmental effects that may be expected from the decommissioning of R&T reactors and is based primarily on information from a study[2] of the conceptual decommissioning of a reference research reactor and of a reference test reactor. The study focused on one research facility and on one test facility, each representing a significant decommissioning task. Because it was not practical to include in one study examples of the decommissioning of all classes of R&T reactors, by examining selected facilities and some components and operations common to many facilities, the study provided data that would be useful in estimating the requirements and costs of decommissioning other facilities not specifically considered.

The reference test reactor is assumed to be located at the generic site described in Section 3.1. The reference site used for the study of the reference research reactor is the campus of a large university and is described in Section 3.2. As part of the study, PNL developed information on the available technology, safety considerations, and probable costs for decommissioning the reference R&T reactors at the end of their useful operational lives. In addition as part of an addendum[3] to the study,[2] PNL analyzed selected cases to consider the sensitivity of decommissioning costs and radiation doses to reactor size.

7.1 Description of R&T Reactors

7.1.1 Reference Research Reactor

The reference research reactor is the Oregon State University TRIGA Reactor at Corvallis, Oregon. This reactor is a 1 MWt, above-ground, open-pool nuclear training and research facility. The reference research reactor is made up of a reactor tank and a core structure and a TRIGA type control system. Major structures comprising the reference research reactor include a reactor building (housing the TRIGA reactor and support area), a cooling tower, an annex (housing a hot laboratory area and hot cell), a heat exchanger building (housing a water purification system, water pumping systems, and air compressor systems), a pump house (housing a liquid waste retention tank), and a radiation center building (housing a waste processing and storage room).

7.1.2 Reference Test Reactor

The reference test reactor is the Plum Brook Reactor at Sandusky, Ohio operated by the National Aeronautics and Space Administration. The Plum Brook reactor is a 60 MWt materials test reactor, light water moderated and cooled, used in testing materials for certain applications. Although Plum Brook has been actually shut down since 1973 it is analyzed in the study[2] as if it had recently been shut down. The testing system of the Plum Brook reactor is made up principally of the test reactor vessel (containing the nuclear core and experimental beam tubes) and the reactor water recirculation system. Major structures comprising the reference test reactor include a reactor building (housing the test reactor), a hot laboratory building with seven hot cells, a primary pump house, an office and laboratory building (housing radiochemistry laboratories), a fan house (housing ventilation systems and waste ion exchangers and filters), a hot retention area (holding waste tanks), a cold retention area, an emergency retention basin, and a waste handling building.

7.2 Research and Test Reactor Decommissioning Experience

Due to the relatively large number of research and test reactors in the U.S. and the diversity of their use, a number of research and test reactors have either been decommissioned by the use of DECON or are being decommissioned by placing them into safe storage. A list of experience with decommissioning of research and test reactors is given in Table 7.2-1. These experiences indicate that the basic technologies for decontamination and dismantlement of these types of R&T reactors have been carried out successfully and can be modified as necessary to suit site-specific conditions.

7.3 Decommissioning Alternatives

Once a research or test reactor has reached the need of its useful operating life it must be decommissioned. As discussed in Section 2.3, this means safely removing the facility from service and disposing of all radioactive materials in excess of levels which would permit unrestricted use of the property. Several alternatives are considered here as to their potential for satisfying this general requirement for decommissioning. The decommissioning alternatives considered and discussed here are DECON, SAFSTOR, and ENTOMB. The alternative used depends on such considerations as cost, dose, physical design of the facility, types of residual radioactivity present, proposed use of the site, and desirability of terminating the license.

Discussion of the decommissioning alternatives follows:

7.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use.

Table 7.2-1 Experience with research and test reactor decommissionings[a]

	Thermal Power	End of Operation	Decommissioning Method
Illinois Inst of Tech.	100 kW	1967	DECON
USN Research Lab	1 MW	1970	DECON
NC State	100 W	1963	DECON
Industrial Reactor Labs	5 MW	1975	DECON
US Navy Post Graduate School	0.1 W	1971	DECON
North American Aviation	5 W	1958	DECON
Oklahoma State Univ.	0.1 W	1974	DECON
Navy Hospital	5 W	1962	DECON
University of Akron	0.1 W	1967	DECON
Univ. of Calif.	0.1 W	1966	DECON
Univ. of Delaware	0.1 W	1977	DECON
Gulf United Nuclear	100 W	1971	DECON
Oregon State Univ.	0.1 W	1974	DECON
Rice Univ.	15 W	1965	DECON
Univ. of Wyoming	10 W	1974	DECON
Polytechnic Inst. of NY	0.1 W	1973	ECON
Walter Reed Medical Ctr.	50 kW	1971	DECON
Lockheed	3 MW	1970	DECON
Univ. of Nevada	10 W	1974	DECON
General Dynamics	500 W	1965	DECON
General Atomic Co	1.5 MW	1973	DECON
Gulf General Atomic	500 W	1967	DECON
Gulf Oil	500 W	1973	DECON
NUMEC	1 MW	1966	DECON
Battelle Memorial Inst.	2 MW	1974	SAFSTOR
Watertown Arsenal	5 MW	1970	SAFSTOR
Rockwell Inter. Corp	10 W	1974	SAFSTOR
Oregon State Univ.	0.1 W	1978	SAFSTOR
NC State Univ.	10 kW	1973	SAFSTOR
West Virginia Univ.	75 W	1972	SAFSTOR
Stanford Univ	10 kW	1974	SAFSTOR
NASA Mock-up	100 kW	1973	SAFSTOR
Calif. Polytech. Univ.	0.1 W	1978	SAFSTOR
Diamond Ordnance Facility	250 kW	-	DECON
Ames Laboratory	5 MW	-	DECON
Lynchburg Pool Reactor	1 MW	-	DECON
Westinghouse Test Reactor	60 MW	1962	SAFSTOR
Plum Brook Test Reactor	60 MW	1974	SAFSTOR
Saxton Test Reactor	28 MW	1972	SAFSTOR
GE EVESR Test Reactor	17 MW	1967	SAFSTOR
B&W BAWTR Test Reactor	6 MW	1971	DECON
SEFOR Sodium Test Reactor	20 MW	1972	SAFSTOR

(a) Adapted from References 2 and 3. Information updated through 1987.

Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. To accomplish DECON, all potentially contaminated systems must be disassembled and removed and all contaminated material must be removed from the facility and be transported to a regulated disposal site. The end result is the release of the site and any remaining structures for unrestricted use shortly after the end of facility operation. Also DECON assumes the availability of capacity to handle wastes requiring disposal.

DECON is advantageous because it allows for termination of the NRC license shortly after cessation of facility operations and removes a radioactive site. DECON is advantageous if the site is required for other purposes or if the site is extremely valuable. It is also advantageous in that the facility operating staff is available to assist with decommissioning and that continued surveillance is not required. A disadvantage of DECON is the higher occupational dose than for other alternatives for research reactors and than for SAFSTOR for test reactors, although as discussed below the difference in dose for the reference research reactor is very small and for the reference test reactor it is not substantial.

The PNL study shows that, for the reference research reactor, DECON would require about 1.7 years to complete, including 1 year for planning and preparation, prior to final reactor shutdown, and, for the reference test reactor, DECON would require about 4.1 years to complete, including 2 years for planning and preparation. The costs (updated to 1986 dollars) for DECON for the reference R&T reactors are given in Tables 7.3-1 and 7.3-2, respectively.

Three important radiation exposure pathways need to be considered in the evaluation of the radiation safety of normal reactor decommissioning operations: inhalation, ingestion, and external exposure to radioactive materials. For reasons similar to that discussed for PWRs in Section 4.3.1, during decommissioning the dominant exposure pathway to workers is external exposure while for the public the dominant exposure pathway is inhalation. During the transport of radioactive waste, the dominant exposure pathway is external exposure for both transportation workers and the public. A summary of the occupational doses resulting from these pathways for the reference research and test reactors is presented in Tables 7.3-3 and 7.3-4, respectively. The dose to the public from radionuclide releases during DECON activities and from truck transportation of radioactive waste from DECON at the reference research reactor is estimated to be negligible (less than 0.1 man-rem). The dose to the public from routine releases during DECON activities at the reference test reactor are estimated to be negligible and the dose to the public from truck transport of wastes from the reference test reactor is estimated to be 2.2 man-rem.

7.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a research or test reactor in such condition that the risk to safety is within acceptable bounds, and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

An advantage of SAFSTOR is that there is reduction in occupational and public dose although as can be seen from Tables 7.3-3 and 7.3-4 the occupational doses from the reference research reactor do not decay by a large amount and the dose

Table 7.3-1 Summary of estimated costs for decommissioning the reference research reactor in $ millions [a,b]

Decommissioning Element[c]	DECON	SAFSTOR 10 Years	SAFSTOR 30 Years	SAFSTOR 100 Years	ENTOMB[c]
DECON	1.22	NA[d]	NA	NA	NA
Entombment	NA	NA	NA	NA	0.74
Safe Storage Preparation	NA	0.67	0.67	0.67	NA
Continuing Care	NA	0.41	1.3	4.3	0.008/yr
Deferred Decontamination	NA	1.21	1.08	0.95	NA
Total	1.22	2.29	3.05	5.92	0.74 + $8K/yr

(a) Values include a 25% contingency and are in constant 1986 dollars.

(b) Values exclude cost of disposal of last core and cost of demolition of nonradioactive structures.

(c) Adapted from Reference 2.

(d) NA-not applicable.

Table 7.3-2 Summary of estimated costs for decommissioning the reference test reactor in $ millions [a,b]

Decommissioning Element[c]	DECON	SAFSTOR 10 Years	SAFSTOR 30 Years	SAFSTOR 100 Years	ENTOMB[c]
DECON	24.2	NA[d]	NA	NA	NA
Entombment	NA	NA	NA	NA	21.3
Safe Storage Preparation	NA	10.9	10.9	10.9	NA
Continuing Care	NA	1.5	4.6	15.5	0.052/yr
Deferred Decontamination	NA	14.4	14.4	11.2	NA
Total	24.2	26.8	29.9	37.6	21.3 + $52K/yr

(a) Values include a 25% contingency and are in constant 1986 dollars.

(b) Values exclude cost of disposal of last core and cost of demolition of nonradioactive structures.

(c) Adapted from Reference 2.

(d) NA-not applicable.

Table 7.3-3 Summary of radiation safety analyses for decommissioning the reference research reactor (values are in man-rem)[(a)]

	DECON	SAFSTOR 10 Years	SAFSTOR 30 Years	SAFSTOR 100 Years	ENTOMB
Occupational Exposure					
Safe Storage Preparation	NA	13.1	13.1	13.1	NA
Continuing Care	NA	0.5	0.8	0.8	neg.
Decontamination	18.3	1.5	0.1	0.1	NA
Entombment	NA	NA	NA	NA	16.6
Safe Stor. Prep. Truck Shipments	NA	0.1	0.1	0.1	NA
Decontamination Truck Shipments	0.3	neg	neg	neg	NA
Entombment Truck Shipments	NA	NA	NA	NA	0.1
Total	18.6	15.2	14.1	14.1	16.7

(a) All entries are from Reference 2. NA means not applicable and neg means negligible.

Table 7.3-4 Summary of radiation safety analyses for decommissioning the reference test reactor (values are in man-rem)[(a)]

	DECON	SAFSTOR 10 Years	SAFSTOR 30 Years	SAFSTOR 100 Years	ENTOMB
Occupational Exposure					
Safe Storage Preparation	NA	112	112	112	NA
Continuing Care	NA	neg	neg	neg	neg
Decontamination	322	86	6	1	NA
Entombment	NA	NA	NA	NA	425
Safe Stor. Prep. Truck Shipments	NA	12	12	12	NA
Decontamination Truck Shipments	22	2	neg	neg	NA
Entombment Truck Shipments	NA	NA	NA	NA	19
Total	344	212	130	125	444

(a) All entries are from Reference 2. NA means not applicable and neg means negligible.

reduction from the reference test reactor is marginally significant. In addition as noted in Section 7.3.1 the public dose from the reference research reactor is negligible and from the reference test reactor is very small. Other reasons for use of SAFSTOR include shortage of radioactive waste disposal space offsite or presence of other nuclear facilities onsite. A disadvantage of SAFSTOR is that the licensee is required to maintain a possession only license and to meet its requirements at all times during safe storage thus contributing to the number of sites dedicated to radioactive confinement for an extended time period. Other disadvantages are that surveillance is required, the dollar costs are higher than for DECON, and the experienced operating staff may not be available at the end of the safe storage period to assist in the deferred decontamination.

The PNL study shows that the costs of SAFSTOR are greater than those of DECON and vary with the number of years of safe storage. Tables 7.3-1 and 7.3-2 present a summary of estimated costs (updated to 1986 dollars) for decommissioning the reference research and test reactors, respectively.

The estimated radiation doses due to SAFSTOR at the reference research and test reactors are estimated in the PNL study[2] and a summary of the occupational doses for these facilities are contained in Tables 7.3-3 and 7.3-4. The dose to the public during SAFSTOR activities and truck transport of radioactive wastes from SAFSTOR at the reference research reactor are estimated to be negligible (less than 0.1 man-rem). For the reference test reactor, the dose to the public from routine releases during SAFSTOR activities are estimated to be negligible and the dose to the public from truck transport of wastes is estimated to be 0.35, 0.14 and 0.11 manrem for storage periods of 10, 30, and 100 years respectively.

7.3.3 ENTOMB

ENTOMB of a research or test reactor requires its encasement in concrete to protect the public from radiation exposure until its radioactivity has decayed to levels permitting release of the facility for unrestricted use. The amount and the half-life of the residual radioactive material in the facility to be entombed determines the time period that the integrity of the structure must be assured. ENTOMB includes the entire process of first entombing and then continuing some surveillance to assure the integrity of the structure until the encased material is confirmed to have decayed enough to allow unretricted release. ENTOMB also requires a nuclear license to remain in force. The facility and site preparations include comprehensive cleanup and decontamination outside of and confinement of nonreleasable materials within the encasement structure. Continuing care activities are minimal.

For much the same reasons as is discussed in Sections 4.3.3 and 5.3.3 ENTOMB with the internals in place would probably not be viable due to the long-lived nuclides contained in the internals. The information presented in Tables 7.3-1 through 7.3-4 are based on entombing the reactor with the reactor internals removed. The postulated entombment structure for the reference research reactor is the entire concrete structure housing the TRIGA reactor, and for the reference test reactor the entombment structure encompasses the below grade portion of the reactor containment vessel. Radioactive materials not entombed would have to be packaged and transported to a burial site. ENTOMB has some advantage because of reduced occupational exposure at the reference research reactor however the amount of reduction is very small (less than 2 manrem). For the reference test reactor ENTOMB results in increased occupational exposure partly due to the exposure received in constructing the entombment structure. As was noted for SAFSTOR in Section 7.3.2 the effect of use of ENTOMB on public dose is small since public doses are already very small even for DECON. Another advantage of ENTOMB occurs if there is a shortage of disposal capacity although waste volumes for research reactors are small. Disadvantages of ENTOMB include the fact that the integrity of the entombing structure must be assured and surveillance and monitoring would be required for an extended time, and that entombing contributes to the number of sites dedicated to radioactive containment for very long time periods. A difficulty with ENTOMB is that the radioactive materials remaining in the entombed structure would need to be characterized well enough to be sure that they decay to acceptable levels at the end of the surveillance period, otherwise deferred decontamination would become necessary which would make ENTOMB more costly and difficult. Also, ENTOMB would seem an unlikely choice for a university research reactor where space is at a premium.

The costs (updated to 1986 dollars) of ENTOMB for the reference research and test reactors are summarized in Tables 7.3-1 and 7.3-2 respectively. As can be seen, the cost of ENTOMB is higher than the cost of DECON when the costs of surveillance for an extended time are added in.

The estimated radiation doses due to ENTOMB are summarized in Tables 7.3-3 and 7.3-4. For the reference research reactor the dose to the public during ENTOMB activities and truck transport are estimated to be negligible (less than 0.1 man-rem). For the reference test reactor, the dose to the public during ENTOMB activities is estimated to be negligible and the dose during truck transport of wastes is estimated to be 1.3 manrem (Table N. 5-2 Vol. 2 of reference 2).

7.3.4 Sensitivity Analysis

In an addendum[3] to the original PNL study[2] PNL analyzed five selected cases to consider the sensitivity of decommissioning costs and radiation doses to plant size. The five cases are listed in Table 7.3-5. The analysis took the form of obtaining data on the radiation doses and costs from these cases and putting the costs on a common year basis of 1981 dollars. The costs (updated to 1986 dollars) and doses are also summarized in Table 7.3-5. The PNL study noted that quantitative data sufficient to correlate radiation dose to reactor size or type in a meaningful way do not exist. Costs of decommissioning do appear to have some relationship to power rating although no scaling factor or correlation was developed. The benefit of this analysis is that it provides information on the type of ranges of dose and costs of decommissioning that may be encountered for various types of research and test reactors. An important item noted in the addendum is that the sensitivity results presented are subject to a large number of variables, each with wide ranges of values, that can possibly impact on costs and radiation exposure estimates for other nuclear R&T facilities. Due to the many variables involved, including facility size, number and type of ancillary facilities, facility design and construction, type of labor utilized, use of subcontractors, and operating practices during the facility lifetime, the relationship noted is not necessarily a fixed relationship. Hence interpolation of the data for different type facilities can be misleading and in particular extrapolation of the data to larger power facilities is not practical.

Table 7.3-5 Comparison of data from selected cases of research reactor decommissioning

Reactor	Thermal Power	Occupational Dose (man-rem)	Adjusted Cost, Millions (1986 dollars)
Diamond Ordnance Facility	250 kW	< 2	0.497[a]
Ames Laboratory	5 MW	69	5.931[a]
Lynchburg Pool Reactor	200 kW (natural convection) 1 MW (forced convection)	<0.1	0.102[a]
NC State University	10 kW	< 2[b]	0.230(b)
Oregon State University	0.1 W	Neg[c]	0.014[a]

[a]Adapted from Reference 3.

[b]Based on Reference 4.

[c]Neg means negligible.

7.4 Environmental Consequences

An environmental consequence of decommissioning, other than radiation dose which is discussed above in Section 7.3, is the commitment of land area to the disposal of radioactive waste. The volume of low-level radioactive waste to be disposed of during DECON is estimated[2] to be 160 m^3 and 4930 m^3 for the reference research reactor and reference test reactor respectively. Waste volumes will decrease during SAFSTOR due to reduced quantities of radionuclides and corresponding waste quantities as a result of radioactive decay and for the reference research reactor are estimated[2] to be 100, 29, and 29 m^3 for 30, 50, and 100 years of storage, respectively, and for the reference test reactor are estimate to be 4930, 2960, and 2940 m^3 for 30, 50, and 100 years of storage, respectively. For ENTOMB, the waste volumes are estimated to be 21 m^3 and 2930 m^3 for the reference research reactor and test reactor, respectively. The volumes indicated are those required to accommodate radioactive waste and rubble removed from the facility and be transported to a licensed site for disposal. The volume for ENTOMB does not include the volume of the entombing structure or of the wastes entombed within it. The waste volumes requiring burial would represent a use of less than 0.1 acre of land for disposal for the reference research reactor and about one-half acre for the reference test reactor. This amount is not large in comparison with the size of the reference research reactor site (approximately 40 acres) and the reference test reactor site (approximately 1200 acres) which could now be released for unrestricted use.

PNL considered accidental releases of radioactivity both during decommissioning during transport of wastes and the results are presented in Tables 7.4-1 and 7.4-2. Radiation doses to the maximum-exposed individual from accidental airborne radioactivity releases during decommissioning operations were calculated to be quite low. Radiation doses to the maximum-exposed individual from accidental radioactivity releases resulting from transportation accidents were calculated to be low for the most severe accident.

The socioeconomic impacts are mainly from the shutdown (not decommissioning) of the research or test reactor which would result in the loss of certain jobs and income to the community. The overall impact from the reference research reactor is likely to be small since the facility is not a revenue producing facility.

7.5 Comparison of Decommissioning Alternatives

From examination of Tables 7.3-3 and 7.3-4, occupational and public doses are much less significant and much easier to manage than for the power reactors discussed earlier in the final GEIS. Hence, DECON is probably the most reasonable option. In addition, costs of DECON are less than those for SAFSTOR. 30-year or 50-year SAFSTOR may be justified in some cases where other factors exist such as waste disposal problems or presence of other nuclear facilities on-site, combined with the potential for reduced occupational dose. 100-year SAFSTOR is not considered a reasonable option since it results in the continued presence of a site dedicated to radioactivity containment for an extended time period with little benefit in dose or waste volume reduction compared to 30-year or 50-year SAFSTOR. ENTOMB is unlikely to be a reasonable option for research and test reactors since it results in the presence of a radioactive site for an extended period of time, and due to the lack of significant benefit in dose or waste volume reduction compared to the other alternatives, and the lack of significant cost reduction compared to the other alternatives. In addition, uncertainties regarding characterizaton of residual radioactivity over the entombment period might result in additional costly decommissioning activity in order to release the facility for unrestricted use.

Table 7.4-1 Summary of radiation doses to the maximum-exposed individual from accidental radionuclide releases during decommissioning at the reference research reactor[a]

Accident	Total Atmospheric Release[b] (Ci/Hr)	Frequency of Occurrence[c]	Radiation Dose to Lung (rem) from: First-Year Dose	Radiation Dose to Lung (rem) from: 50-Year Committed Dose Equivalent
Oxyacetylene Explosion	5.2×10^{-2}	Medium	1.2×10^{-3}	1.6×10^{-3}
HEPA Filter Failure[d]	2.6×10^{-4} 1.0×10^{-5}	Low	7.3×10^{-7} 2.4×10^{-7}	7.8×10^{-7} 3.1×10^{-7}
Severe Transportation Accident[d,e]	5.2×10^{-5}	Low	4.1×10^{-4}	8.3×10^{-4}
LPG Explosion[d]	1.4×10^{-5}	Low	3.9×10^{-8}	4.2×10^{-8}
Vacuum Filter-Bag Rupture	1.8×10^{-6}	Medium	4.3×10^{-8}	5.6×10^{-8}
Minor Transportation Accident[d]	1.3×10^{-6}	Low	1.0×10^{-5}	2.1×10^{-5}
Accidental Cutting of Activated Al in Air[d]	2.9×10^{-7}	High	6.9×10^{-9}	9.1×10^{-9}
Contaminated Sweeping Compound Fire[d,e]	1.9×10^{-9}	Medium	5.3×10^{-12}	5.7×10^{-12}
Combustible Waste Fire[d,e]	9.0×10^{-10}	High	1.5×10^{-10}	3.2×10^{-10}

(a) Adapted from Reference 2.

(b) For comparison, all accidental releases are assumed to occur in a 1-hr period.

(c) The frequency of occurrence considers not only the probability of the accident, but also the probability of an atmospheric release of the calculated magnitude. The frequency of occurrence is listed as "high" if the occurrence of a release of similar magnitude is $> 10^{-2}$ per year, as "medium" if between 10^{-2} and 10^{-5}, and as "low" if $<10^{-5}$.

(d) The accident shown applies to both DECON and SAFSTOR.

(e) The accident shown applies to both DECON and ENTOMB.

Table 7.4-2 Summary of radiation doses to the maximum-exposed individual from accidental radionuclide releases during decommissioning at the reference test reactor[a]

Accident	Total Atmospheric Release[b] (Ci/hr)	Frequency of Occurrence[c]	Radiation Dose to Lung(rem) from: First-Year Dose	Radiation Dose to Lung(rem) from: 50-Year Committed Dose Equivalent
Oxyacetylene Explosion	5.6×10^{-2}	Medium	1.6×10^{-4}	1.7×10^{-4}
LPG Explosion[d]	6.5×10^{-3}	Low	1.8×10^{-5}	2.0×10^{-5}
Severe Transportation Accident	1.0×10^{-3}	Low	7.8×10^{-3}	1.6×10^{-2}
HEPA Filter Failure[d]	5.2×10^{-4} 3.8×10^{-6}	Low	1.5×10^{-6} 9.1×10^{-8}	1.2×10^{-6} 1.2×10^{-7}
Accidental Cutting of Activated Stainless Steel[d]	8.8×10^{-5}	High	2.5×10^{-4}	2.6×10^{-7}
Vacuum Filter-Bag Rupture[d,e]	2.9×10^{-5}	Medium	8.1×10^{-8}	8.7×10^{-8}
Minor Transportation Accident	2.5×10^{-5}	Low	3.8×10^{-5}	8.0×10^{-5}
Contaminated Sweeping Compound Fire[d,e]	3.6×10^{-8}	Medium	1.0×10^{-10}	1.1×10^{-10}
Combustible Waste Fire[d,e]	1.8×10^{-8}	High	5.0×10^{-11}	5.4×10^{-11}

(a) Adapted from Reference 2.

(b) For comparison, all accidental releases are assumed to occur in a 1-hr period.

(c) The frequency of occurrence considers not only the probability of the accident, but also the probability of an atmospheric release of the calculated magnitude. The frequency of occurrence is listed as "high" if the occur-rence of a release of similar magnitude is $>10^{-2}$ per year, as "medium" if between 10^{-2} and 10^{-5}, and as "low" if $<10^{-5}$.

(d) The accident shown applies to both DECON and SAFSTOR.

(e) The accident shown applies to both DECON and ENTOMB.

REFERENCES*

1. Code of Federal Regulations, Title 10, Energy, Section 170.3.

2. G.J. Konzek et al., Technology, Safety, and Costs of Decommissioning Reference Nuclear Research and Test Reactors, NUREG/CR-1756, Vols. 1 and 2, Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, February 1982.

3. G. J. Konzek, Technology, Safety, and Costs of Decommissioning Reference Nuclear Research and Test Reactors, NUREG/CR-1756, Addendum, prepared by Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, July 1983.

4. Links, B. W. and R. L. Miller, Evaluation of Nuclear Facility Decommissioning Projects: Summary Report, North Carolina State University Research and Training Reactor, NUREG/CR-3370, prepared by UNC Nuclear Industries for the U.S. Nuclear Regulatory Commission, August 1983.

*See footnote to reference in Chapter 1 for document purchasing availability.

8 DECOMMISSIONING OF REACTORS THAT HAVE BEEN INVOLVED IN ACCIDENTS

The facilities discussed in the preceding sections are representative of facilities which would undergo routine decommissioning at the end of their normal lifetimes. An additional significant area of consideration is the decommissioning that occurs as a result of the premature closure of a reactor due to an accident. A post-operations activities flow sheet showing both a normal decommissioning and the situation for a reactor involved in an accident is shown in Figure 8.0-1.

As can be seen from the figure, the activities following shutdown of a facility involved in an accident are somewhat different from the normal situation. These activities include a stabilization period. The stabilization period is the period during which time the accident is brought under control and the facility is brought to a stabilized condition. Once the situation is stabilized, accident cleanup can begin. Accident cleanup is considered to be those activities leading to defueling the reactor and to cleanup of contamination and processing and disposal of wastes generated by the accident. As shown in Figure 8.0-1, the accident cleanup period could either be followed by recovery of the facility for a restart, or by decommissioning. If, as is analyzed in the GEIS, it is decided that the facility is to be retired from service, decommissioning activities are considered to begin following completion of the accident cleanup.

Much of what follows is based on the NRC-sponsored Pacific Northwest Laboratory (PNL) Study on the technology, safety and costs of decommissioning reference light water reactors following postulated in accidents.[1] For illustration purposes, only the more detailed PWR results are presented. The study did not analyze the stabilization period or the recovery of a facility for restart. The study did present an analysis of the accident cleanup period, including a consideration of the sensitivity of the costs of accident cleanup to several factors, including delays in the cleanup, alternative processing systems, additional structures, alternative disposal requirements, and storage of waste onsite. The accident cleanup period is postulated to include the following tasks: (1) processing the contaminated water generated by the accident (and by decontamination operations); (2) initial decontamination of building surfaces; (3) removal of spent fuel (undamaged and damaged) from the reactor; (4) cleanup of the reactor coolant system; and (5) solidification and packaging of wastes from accident cleanup operations.

As discussed in the PNL study,[1] these accident cleanup tasks are necessary and would be approximately the same whether the reactor is ultimately refurbished or decommissioned, and if decommissioned, the same regardless of which decommissioning alternative is chosen. The rationale for this is that decontamination during the accident cleanup period (whether for eventual restart or decommissioning) cannot be too corrosive since this could compromise the integrity of systems which must remain intact during cleanup and decommissioning, especially if a delayed decommissioning alternative, such as SAFSTOR, is chosen.[1,2] In addition, major equipment items such as the reactor vessel, reactor coolant pumps, and steam generators could not be dismantled until after accident cleanup is completed since they form part of the primary systems.

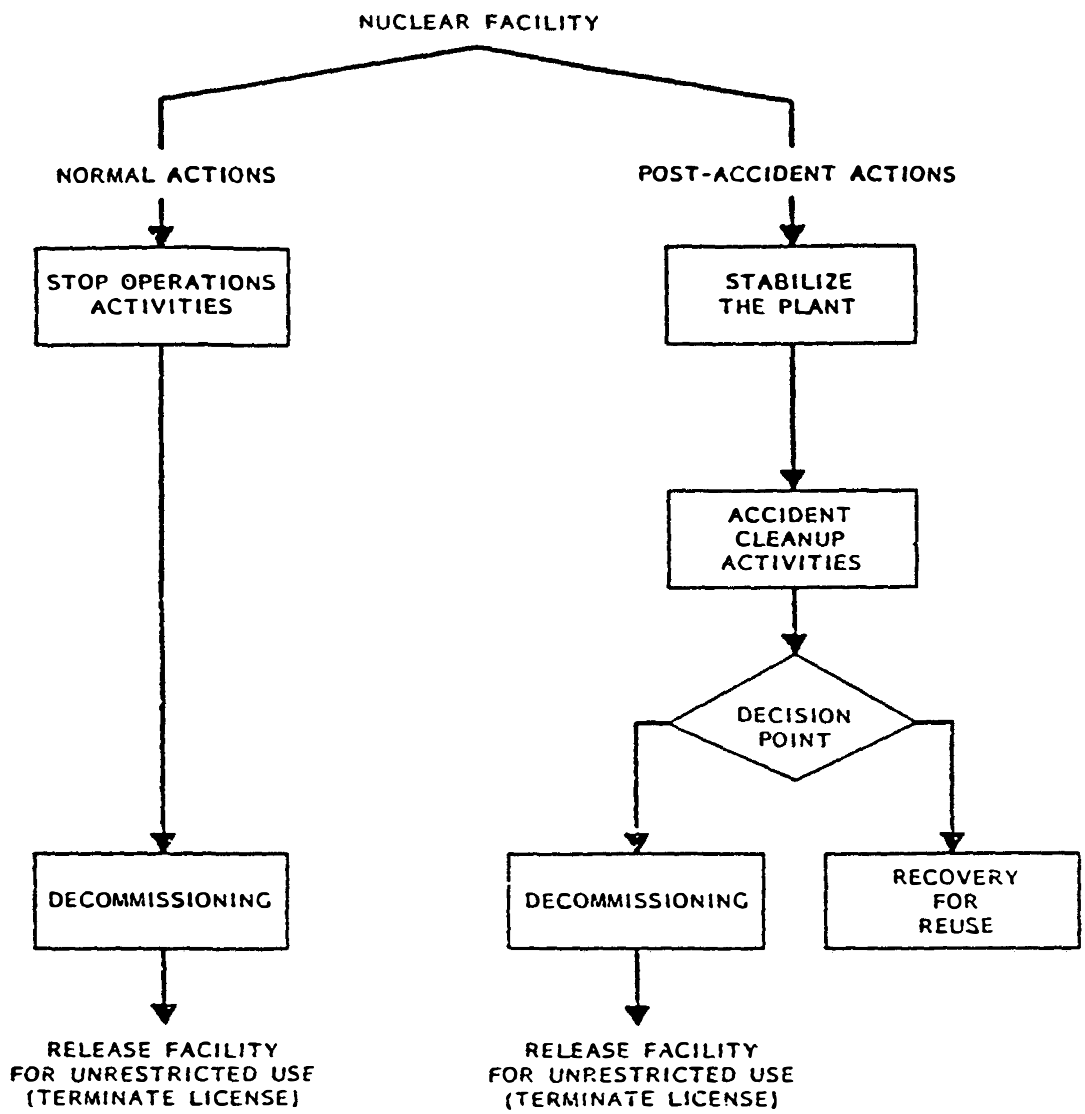

Figure 8.0-1. Post-Operations Activities Flow Sheet

Thus, even if it were decided to permanently shut down a facility following an accident, the sequence of activities would be accident cleanup followed by decommissioning. Because, as discussed in Section 2.6.2, the period of accident cleanup is covered by regulations which require insurance (10 CFR Part 50.54(w)),[3] this GEIS does not present further details on the accident cleanup period. This GEIS does include the effects that the accident and the activities during the accident cleanup period would have on the decommissioning of the facility.

This GEIS section presents a summary of the detailed analysis done by PNL on the decommissioning of a reactor following an accident.[1] Following the completion of the accident cleanup activities, decommissioning activities begin. As a result of the efforts during accident cleanup, the decommissioning activities are considered to be not greatly affected by the condition of the plant immediately following the accident. In addition, many of the uncertain conditions have been removed during the accident cleanup, specifically the damaged core has been removed from the reactor, the large volumes of uncontained highly radioactive water have been processed, the large areas of contaminated building surfaces have been treated, and construction of necessary systems and structures has been completed. Hence, decommissioning can be carried out in a more stable environment than the accident cleanup. Nevertheless, there would be certain impacts on the decommissioning from the accident and the accident cleanup activities including increased levels and spread of contamination compared to normal decommissioning still remaining after the cleanup activities, the need to decommission systems and structures built and used during accident cleanup, and the potential need to store wastes generated by the accident, and during the accident cleanup period, onsite on an interim basis for an extended time period.

8.1 Reference Facility Description and Reference Accident Scenarios

The reactors used as the reference facilities for the post-accident decommissioning analysis are the same as those used as the reference PWR and BWR in Chapters 4 and 5, respectively. The choice of these facilities as the reference reactors is made to facilitate comparisons between the requirements and costs of post-accident decommissioning given in this section and the requirements and costs of normal shutdown decommissioning given in the earlier chapters, and is not intended to imply anything about the reliability and/or safety of these reference reactors relative to other PWRs or BWRs in operation or under construction. The reference site used in this section is the same as that indicated in Section 3.

Three reference accident scenarios are analyzed to illustrate a range of technological requirements, public and occupational doses, and costs that are greater than those estimated for decommissioning following normal shutdown. For the purposes of this GEIS, the consequences of an accident (i.e., the radiological and physical condition of the plant following an accident) are much more important than the sequence of events that occur during the accident. Therefore, detailed descriptions of accident sequences were not analyzed. The reference accident scenarios provide information about radioactive contamination, radiation exposure rates, and damage to the fuel core and to the containment building. The consequence scenarios chosen for this study are believed to be credible with respect to initiating circumstances and are in agreement with scenarios currently considered as design basis by the NRC in safety evaluations. The postulated scenarios, listed in increasing order of the difficulty of post-accident decommissioning, are:

1. A small loss-of-coolant accident (LOCA), e.g., a small steam line break or the inadvertent opening of a safety or relief valve) in which the emergency core cooling system (ECCS) functions to cool the core and to limit the release of radioactivity. Some fuel cladding rupture is postulated, but no fuel melting. The consequence scenario includes moderate contamination of the containment building but no significant physical damage to the building and equipment.

2. A small LOCA in which ECCS is delayed, resulting in 50% fuel cladding failure and a small amount of fuel melting. The consequence scenario includes extensive radioactive contamination of the containment building but only minor physical damage to the building and equipment. It also includes radioactive contamination of auxiliary and fuel handling buildings.

3. A major LOCA (e.g., the rupture of a main coolant line) in which ECCS is delayed, resulting in 100% fuel cladding failure and significant fuel melting and core damage. The postulated consequences include extensive radioactive contamination of the containment building and major physical damage to structures and equipment. Some radioactive contamination of the auxiliary and fuel buildings is also postulated.

This GEIS does not consider the advisability or merit of permanently shutting down a facility which has been involved in one of the accident scenarios described above.

8.2 Post Accident Decommissioning Experience

Very few reactor accidents have occurred that have necessitated extensive post-accident cleanup operations or have resulted in a requirement to decommission the reactor. Primarily, the accidents that have resulted in significant contamination have occurred at small experimental or test reactors. One large reactor, the Three Mile Island Nuclear Plant, has experienced an accident that resulted in significant contamination similar to that discussed in Section 8.1.[2] Information on cleanup and decommissioning experience is contained in Table 8.2-1. The experience at these facilities provides useful information about cleanup procedures and decommissioning accident damaged facilities.

Most of the techniques and procedures used to decontaminate or decommission a reactor following an accident are similar to those used for reactor decommissioning following normal shutdown, although considerations must be given to the problems of working in higher radiation environments than normal. Some reactor accidents have resulted in high levels of radioactive contamination on building surfaces and equipment and in high radiation exposure rates to accident cleanup personnel. In all cases where contamination has occurred, methods and procedures have been devised to safely remove the contamination with only modest total radiation doses to decontamination workers.

The March 28, 1979, accident at Three Mile Island, Unit 2[2] (TMI-2) resulted in an accident cleanup effort at that facility which will involve years of work.[2]

Table 8.2-1 Summary of nuclear reactor post-accident cleanup and decommissioning experience(1)

Facility name and location	Reactor type	Power level	Year of accident	Status following accident cleanup
Canadian NRX	Research, pool	10MW	1952	Returned to service
Canadian NUR	Research, heavy water	200MW	1958	Returned to service
SL-1 Reactor	Military, BWR	3MW	1961	Decommissioned
PRTR	Research, heavy water	--	1965	Returned to service
Enrico Fermi	Fast breeder	--	1966	Returned to service
Lucens	Experimental, heavy water	30MW	1969	Decommissioned
Three Mile Island	Commercial, PWR	2800MW	1979	Still in accident cleanup(2)

(1) Data in table taken from Reference 1.
(2) No decision made as to eventual plant status.

Cleanup of TMI-2 will provide experience in procedures and techniques related to the processing of highly contaminated liquids, the removal of damaged fuel from a reactor, and the handling and disposal of high-activity radioactive waste.

8.3 Decommissioning Alternatives

Under normal circumstances, decommissioning follows the orderly shutdown of the facility at the end of its planned life. However, as discussed above in Section 8.0, decommissioning at a reactor which has been involved in an accident would take place following stabilization and accident cleanup activities. As defined in Section 2.3 decommissioning means safely disposing of all radioactive materials in excess of levels which would permit unrestricted use of the facility.

The accident and the subsequent accident cleanup activities have an effect on decommissioning activities, on the decommissioning alternatives, and on the cost, safety and environmental consequences of those alternatives. These effects include the larger levels and spread of contamination than would be the case for normal decommissioning with resultant higher occupational exposures; different types of contamination (i.e., Sr-90 and Cs-137 control occupational exposure for post accident decommissioning, whereas Co-60 controls for normal decommissioning); the need to decommission accident cleanup systems; and the potential for interim onsite storage of wastes generated by the accident and by the accident cleanup activities. The following sections discuss the impact of an accident and the accident cleanup activities on the alternatives DECON, SAFSTOR and ENTOMB.

8.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. The end result is the release of the site and any remaining structures for unrestricted use. To achieve an unrestricted use condition the following tasks must be performed during DECON: 1) remove activated and contaminated materials from the reactor building; 2) decontaminate the reactor building to unrestricted release levels; 3) dismantle and decontaminate fuel and auxiliary buildings, and turbine building and other buildings; 4) package and ship all contaminated materials; 5) dispose of all fuels, damaged and undamaged; and 6) survey facility and site for acceptable levels of residual radioactivity.

DECON has the same advantages as outlined in Section 4.3.1, such as making the site available for unrestricted use, the availability of a knowledgeable work force, and the elimination of the need for long term security and surveillance. Disadvantages are also similar to those indicated in Section 4.3.1, including the larger occupational exposure and larger initial requirement for waste disposal space compared to the other alternatives. In particular, following an accident the difference in occupational exposure between DECON and SAFSTOR is higher than it is for normal decommissioning (see Table 8.3.2). Also, following an accident, there is a potential that the reactor may be unable to dispose of wastes generated during the accident cleanup which could result in the need for extended onsite storage of wastes. (These wastes could include low-level wastes, as well as high level wastes and fuel assemblies). If this occurs, DECON of the reactor site would not be feasible.

The cost of DECON as estimated by the PNL study following the accident cleanup activities is given in Table 8.3-1 for the three reference accident scenarios. The occupational and public exposure resulting from the DECON activities, as estimated by the PNL study, is given in Table 8.3-2 for the three reference accident scenarios.

8.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a reactor in such condition that the risk to safety is within acceptable bounds, and that the facility can be stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

The advantages of SAFSTOR are similar to those indicated in Section 4.3.2, including the reduction in occupational exposure resulting from the deferral of some decommissioning tasks, and the reduction in waste disposal requirements. Disadvantages of SAFSTOR are similar to those indicated in Section 4.3.2, including need for continuing security and surveillance, the need to maintain a site, and the need to use personnel unfamiliar with the facility for the deferred decontamination.

Table 8.3-1 Summary of estimated costs for decommissioning of the reference PWR following accident cleanup

Decommissioning alternatives	Costs of ($ millions)[a][b] Scenario 1 accident	Scenario 2 accident	Scenario 3 accident
DECON	79.5	104.1	154.8
30 year - SAFSTOR			
Preparations for safe storage	20.0	22.6	28.8
Continuing care costs	4.0	4.0	4.0
Deferred decontamination	67.6	88.5	131.6
Total 30-year SAFSTOR costs	91.6	115.1	164.4
100 year - SAFSTOR			
Preparations for safe storage	20.0	22.6	28.8
Continuing care costs	13.8	13.8	13.8
Deferred decontamination	52.5	68.7	102.2
Total 100-year SAFSTOR costs	86.3	105.1	144.8
ENTOMB[c]			
Entombment	57.4	76.1	111.8
Continuing care costs (for 100 years)	7.2	7.2	7.2

[a] Costs are in early 1986 dollars and include a 25% contingency.

[b] Updated from Reference 1, Table 2.10-5.

[c] If required, deferred decontamination at the end of the continuing care period for ENTOMB is estimated to cost at least as much and perhaps more than deferred decontamination at the end of the corresponding continuing care period for SAFSTOR.

Table 8.3-2 Summary of radiation safety analysis for decommissioning the reference PWR following accident cleanup[a]

	Dose (man-rem)			
		SAFSTOR		
	DECON	30 years	100 years	ENTOMB
Occupational exposure[b][d]				
Safe storage preparation	NA[f]	429	429	NA
Continuing Care	NA	120	225	2,518
Decontamination	3,063	1,500	300	NA
Entombment	NA	NA	NA	2
Safe stor. prep. truck shipments	NA	13	13	NA
Decontamination truck shipments	200	100	20	NA
Entombment truck shipments	NA	NA	NA	90
Total	3,263	2,162	987	2,608
Public exposure[c][e]				
Safe storage preparation	NA	neg.	neg.	NA
Continuing care	NA	neg.	neg.	neg.
Decontamination	neg.	neg.	neg.	NA
Entombment	NA	NA	NA	neg.
Safe stor. prep. truck shipments	NA	1.2	1.2	NA
Decontamination truck shipments	19	9.5	1.9	NA
Entombment truck shipments	NA	NA	NA	8.4
Total	19	10.7	3.1	8.4

[a]Values given are for decommissioning following the accident cleanup of the scenario 2 accident.

[b]Values for occupational exposure for decommissioning following a scenario 3 accident are estimated to be a factor of 2 to 3 times higher than the scenario 2; for a scenario 1 accident, exposures are estimated to be 2 to 5 times lower.[1]

[c]Values for public exposure for decommissioning following a scenario 3 accident are estimated to be a factor of 2 to 5 times higher than for the scenario 2; for scenario 1 accident, exposures are estimated to be 2 to 5 times lower.

[d]From Reference 1, Tables 14.3-4, 14.3-5, and 14.3-7.

[e]From Reference 1, Tables 14.3-2 and 14.3-7.

[f]NA - not applicable.

[g]Neg - dose is estimated to be less than 0.001 man-rem.

In particular, following an accident the amount of benefit in dose reduction is not as great with SAFSTOR as it is for normal decommissioning. This is because the occupational exposures during post accident decommissioning are primarily due to Sr-90 and Cs-137 which are released from the fuel during the accident and contaminate building and piping surfaces. Sr-90 and Cs-137 have half-lives of approximately 30 years. This is different from the normal situation where occupational exposures are primarily due to Co-60 which has a half-life of 5.27 years. Because of the long half-life of the controlling nuclides it would take a longer time period to reduce occupational exposures. 30-year SAFSTOR reduces exposures by a factor of approximately 1.5 and 100-year SAFSTOR only reduces dose by a factor of 4 (compared to normal decommissioning where 30-year SAFSTOR results in a dose reduction of 4). Thus, long SAFSTOR periods would be necessary to accomplish occupational dose reduction.

Use of SAFSTOR might be likely if it is necessary to provide for interim onsite storage of wastes for an extended period of time into the decommissioning period. This might occur because of political or regulatory constraints against disposal of waste, because of inadequate disposal capacity for low level waste, or lack of disposal sites for high level waste, including the spent fuel. It is unlikely that most reactor sites could qualify as permanent waste repositories because of such factors as nearby population densities and hydrology. Therefore, storage of wastes onsite would be an interim measure, albeit for an extended time, followed ultimately by decontamination of the facility and site.

The cost of SAFSTOR of the reactor as estimated by the PNL study following the accident cleanup activities is given in Table 8.3-1 for the three accident scenarios. The occupational and public exposure resulting from the SAFSTOR activities, as estimated by the PNL study, is given in Table 8.3-2 for the three reference accident scenarios.

8.3.3 ENTOMB

ENTOMB is the complete isolation of radioactivity from the environment by means of massive concrete barriers until the radioactivity has decayed to levels which permit release of the facility for unrestricted use.

ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within reasonable time periods. Recommended policy on reliance on institutional control for containment of radioactivity is approximately 100 years.[4] Some of the discussion of Section 4.3.3 concerning ENTOMB is pertinent here, including advantages and disadvantages, structures which would be entombed, and certain nuclides which would be involved. However, there are certain important considerations for ENTOMB as a post-accident decommissioning alternative that makes it less attractive as an alternative than it is for normal decommissioning. This is because of the higher levels of the entombed radioactivity resulting from accident-generated contamination in the plant, and slower decay of the post-accident radionuclide inventory which is controlled by Sr-90 and Cs-137, with 30-year half-lives. Therefore, use of ENTOMB as the decommissioning alternative following an accident would necessitate either a period of retention of the entombed structure for longer than 100 years to allow decay of radioactivity to unrestricted use levels, or an eventual deferred contamination of the entombed structure. This decontamination would involve significantly greater time and manpower commitments and costs expenditures than, for example, deferred decontamination for an unentombed structure, since the entombed structure is built to endure for a long period of time.

The occupational and public exposure resulting from ENTOMB activities, as estimated by the PNL study, is given in Table 8.3-2 for the three reference accident scenarios. The cost given in Table 8.3-1 includes the cost of entombing the structure and the annual continuing care costs, but does not include the cost of deferred decontamination which may likely be necessary after approximately 100 years to reduce radioactivity to unrestricted use levels. The cost of the deferred decontamination for ENTOMB is estimated to add at least $33 million, $45 million, and $70 million to the cost of ENTOMB for the reference accident scenarios 1, 2 and 3, respectively.

8.4 Environmental Consequences

This section discusses environmental consequences other than the radiation dose consequences discussed above in Section 8.3. These other consequences include waste disposal, radioactivity released due to industrial accidents during decommissioning, and socioeconomic impacts.

With regard to waste disposal, the volumes of waste to be disposed of during the decommissioning of a reactor, following the accident cleanup of each of the three reference accident scenarios, are contained in Table 8.4-1. These wastes include disposal of neutron activated steel and concrete, contaminated concrete and equipment, and dry and wet radioactive wastes. In arriving at the data in Table 8.4-1, it is assumed that the wastes generated during the accident cleanup period are disposed of prior to the decommissioning period. These wastes include low-level radioactive wastes, as well as highly radioactive and/or transuranic wastes, and damaged and undamaged fuel assemblies. Based on the criteria of 10 CFR Part 61, the low level radioactive wastes resulting from accident cleanup are assumed to be disposed of by shallow land burial. Because the criteria of 10 CFR 61 may result in the high level radioactive wastes and transuranic wastes generated during accident cleanup being deemed unsuitable for shallow land burial, they are assumed to be sent to a federal repository. Similarly, because the criteria for disposal of the damaged and undamaged fuel is not yet well defined it is assumed to be sent to a Federal repository.

Because of the potential that a reactor involved in an accident may be unable to dispose of the wastes including spent fuel generated during accident cleanup as assumed in the previous paragraph, either because of lack of disposal capacity or regulatory or political constraints, there may be onsite storage of both accident cleanup wastes and decommissioning wastes for an extended period of time. This would result in additional surveillance costs and an extension of the completion of decommissioning. Details of this storage are discussed in Section 2.7.

PNL considered releases of radioactivity resulting from industrial accidents during the decommissioning activities and the results are presented in Table 8.4-2. Radiation doses to the maximum exposed individual from accidental airborne radioactivity releases during decommissioning operations were calculated to be quite low. Radiation dose to the maximum-exposed individual from accident radioactivity releases resulting from transportation accidents were calculated to be low for the most severe accident.

Table 8.4-1 Burial volume of radioactive waste and rubble for the reference PWR following the accident cleanup at a reactor involved in an accident[a,b]

Decommissioning alternative		Volume (m^3)[c]
DECON		18800
SAFSTOR		
Total of preparations for safe storage, continuing care and deferred decontamination[b] following safe storage for:	30 years	18800
	100 years	18800
ENTOMB[d]		8200

(a) Values given are for decommissioning following the accident cleanup of the scenario 2 accident.

(b) Values of waste volumes for decommissioning following the accident cleanup of a scenario 1 or scenario 3 accident are estimated to be less than ±5% difference from the values in the table.[1]

(c) From Reference 1, Tables H.1-3, H.2-3, H.2-8, and H.3-3.

(d) Volume of entombing structure and wastes within are not included.

Table 8.4-2 Summary of radiation doses to the maximum-exposed individual from postulated releases due to industrial accidents during post-accident decommissioning[a]

Incident	Total release (μCi/hr)	Radiation dose to lung (rem) during: DECON[d] First-year	DECON[d] Fifty-year	Prep. for safe storage First-year	Prep. for safe storage Fifty-year
Explosion of LPG leaked from loader[b]	1.8×10^{4}	6.1×10^{-4}	1.2×10^{-3}	--[c]	--
Explosion of oxyacetylene during vessel segmentation	3.6×10^{2}	6.1×10^{-6}	1.2×10^{-3}	--	--
Explosion/fire of ion exchange resin	1.9×10^{2}	6.5×10^{-6}	1.3×10^{-5}	--	--
Gross leak during decontamination - spray leak	1.1×10^{2}	3.8×10^{-6}	7.5×10^{-6}	3.8×10^{-6}	7.5×10^{-6}
- liquid leak	3.5×10^{-1}	1.2×10^{-8}	2.4×10^{-8}	1.2×10^{-8}	2.4×10^{-8}
Segmenting undecontaminated RCS piping	1.1×10^{1}	7.3×10^{-7}	7.9×10^{-7}	--	--
Vacuum bag rupture	5.0×10^{0}	--	--	1.7×10^{-7}	3.4×10^{-7}
Loss of contamination control during vessel segmentation	2.3×10^{0}	3.9×10^{-10}	4.4×10^{-8}	--	--
Accidental spraying of concentrated contamination with high pressure spray	6.0×10^{-1}	--	--	2.0×10^{-8}	4.1×10^{-8}
Filter loss during blasting of concrete bioshield	3.0×10^{-1}	2.0×10^{-9}	2.2×10^{-9}	--	--
Loss of portable filtered ventilation enclosure	1.5×10^{-1}	5.1×10^{-9}	1.0×10^{-8}	--	--
Accidental break of contaminated piping	1.1×10^{-1}	--	--	7.3×10^{-9}	7.9×10^{-9}
Fire involving combustible radioactive wastes	3.0×10^{-2}	1.0×10^{-9}	2.0×10^{-9}	1.0×10^{-9}	2.0×10^{-9}

[a] Reference 1, Table 14.3-3.

[b] All releases assumed to occur during a 1-hr period, for comparison purposes.

[c] A dash indicates the particular accident situation is not considered for the decommissioning alternative because either the accident situation does not apply to that alternative or a similar accident of greater consequences is analyzed.

[d] Corresponding doses for ENTOMB are assumed to be the same as those shown for DECON, with the deletion of these situations that arise from activities not undertaken during DECON (e.g., blasting, segmenting of the vessel).

The biggest socioeconomic impact will have occurred before decommissioning started, following the accident at the plant, namely the shutdown of the plant and the accident cleanup. The decommissioning staff will be approximately the same size as the accident cleanup staff. This GEIS does not consider the advisability or merit of whether a facility should be restarted or decommissioned following an accident.

8.5 Comparison of Decommissioning Alternatives

From examination of Tables 8.3-1 and 8.3-2, it appears that DECON or SAFSTOR are reasonable options for decommissioning a reactor following accident cleanup at a reactor that has experienced an accident. DECON costs less than SAFSTOR and its larger occupational radiation dose is considered of marginal significance to health and safety. Either of the two SAFSTOR options would be feasible since due to the long half-lives of the controlling radionuclides, there would be continued reduction in dose beyond the 30-year SAFSTOR. In addition, SAFSTOR may be a necessary alternative to account for the potential need to store accident generated wastes for an extended time period.

ENTOMB appears less desirable for the reasons discussed in Section 8.3.3. Because of the large quantities of contamination and the long half-lives of the controlling nuclides it would be necessary to keep the reactor entombed for a period of time greater than 100 years in order for the facility radioactivity levels to decay to unrestricted use levels. This is not acceptable since it is not consistent with recommended policy on reliance on institutional control for radioactivity confinement. Deferred decontamination of the entombed structure after 100 years would be difficult and result in the ENTOMB alternative being more costly than DECON or SAFSTOR, generating more waste than DECON or SAFSTOR, and causing larger occupational exposures than SAFSTOR.

Table 8.4-3 Summary of estimated radiation doses to the maximum-exposed individual[a] from postulated transportation accidents during decommissioning

Accident severity	Total release (Ci/hr)[b]	First-year dose (rem)			Fifty-year committed dose equivalent (rem)		
		Total-body	Bone	Lung	Total-body	Bone	Lung
Minor	5×10^{-4}	2.5×10^{-4}	6.0×10^{-4}	8.0×10^{-4}	5.5×10^{-4}	4.8×10^{-3}	1.6×10^{-3}
Severe	2×10^{-2}	1.0×10^{-2}	2.4×10^{-2}	3.2×10^{-2}	2.2×10^{-2}	1.9×10^{-1}	6.4×10^{-2}

[a] Reference 1, Table 14.3-8.

[b] Releases assumed to occur in a 1-hr period for comparison purposes.

REFERENCES*

1. E. S. Murphy, G. M. Holter, Technology, Safety and Costs of Decommissioning at a Reference Light Water Reactors Following Postulated Accidents, NUREG/CR-2601, Vols 1 and 2, Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, November 1982.
2. Final Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Nuclear Station, Unit 2, NUREG-0683, Vols. 1 and 2, U.S. Nuclear Regulatory Commission, March 1981.
3. Federal Register, 47 FR 13750, "Elimination of Review of Financial Qualifications of Electric Utilities in Licensing Hearings for Nuclear Power Plants," March 31, 1982.
4. Federal Register, 46 FR 38081, "Licensing Requirements for Land Disposal of Radioactive Waste," July 24, 1981.

*See footnote to reference in Chapter 1 for document purchasing ability.

9 FUEL REPROCESSING PLANT

A fuel reprocessing plant (FRP) is a facility for reclaiming plutonium and uranium from spent nuclear reactor fuel, so that the reclaimed plutonium and uranium can be later refabricated into new fuel elements. For the purpose of this section, it is assumed that the plant is to be operated 30 to 40 years. It is also assumed that any accidental releases of radioactive material are cleaned up immediately following the event. The generic site of a fuel reprocessing plant is described in Section 3.1.

This section is based primarily on a detailed study[1] of the decommissioning of a fuel reprocessing plant conducted by Pacific Northwest Laboratory (PNL) for the NRC. In this study, PNL selected the Barnwell Nuclear Fuel Plant (BNFP), located in Barnwell, South Carolina, as the reference FRP and assumed it to be located at the generic site. Although the Barnwell facility has never operated as an FRP, its design is considered to have characteristics typical of those present in any future FRPs. PNL then developed and reported information on the available technology, safety considerations, and probable costs for decommissioning the reference facility at the end of its operating life.

9.1 Description of Fuel Reprocessing Process and Facility

9.1.1 Process Description

The reference plant uses the Purex process to recover plutonium and uranium from irradiated LWR fuels. A simplified block flow diagram of this process is shown in Figure 9.1-1.

The irradiated fuel is received in heavily shielded casks and is unloaded and stored underwater in the fuel receiving and storage station (FRSS). When ready for processing, each fuel assembly is transferred to the main process building where it is partly disassembled, chopped into pieces up to 10 cm long and dropped into a dissolver vessel where the fuel materials are dissolved with nitric acid. The undissolved fuel cladding hulls are packaged and taken to a bunker-type storage area onsite.

The nitric acid-fuel solution is then subjected to a solvent extraction process where the uranium, plutonium, and fission products are separated into individual streams, and the uranium and plutonium are purified and converted to uranium hexafluoride and plutonium oxide for offsite shipment. The fission products are stored in underground water-cooled tanks for about 5 years and then solidified for disposal in a federal facility.

9.1.2 Plant Description

The major facilities included in the reference reprocessing plant are: 1) the fuel receiving and storage station, 2) the main process building, 3) the high- and intermediate-level liquid waste storage area, 4) the waste solidification plant, and 5) the radioactive auxiliary service areas. Detailed descriptions of these facilities are presented in Reference 1.

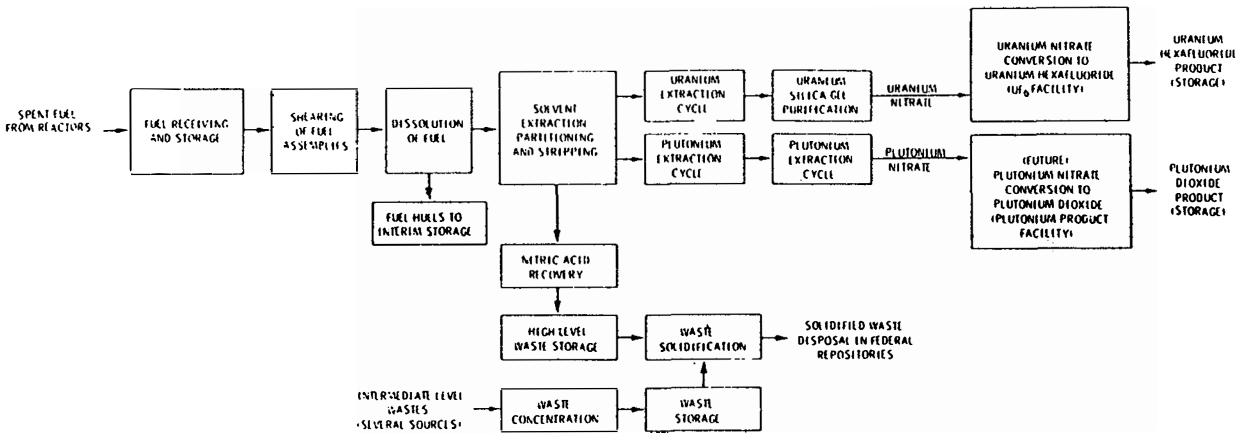

Figure 9.1-1 Simplified Process Flow Diagram for a Fuel Reprocessing Plant

The following is a listing of various operating parameters of the reference FRP:

Inputs to the FRP

Spent Fuels from Light Water Reactors (Zircaloy or stainless steel cladding) with the following content:

- UO_2 (up to 3.5% enrichment when input to the reactor)
- UO_2-PuO_2 (Pu up to equivalent of 3.5% ^{235}U when input to the reactor)
- Special fuels up to 5% initial enrichment under special operating conditions

Spent Fuel Burnup[a]:

- From PWRs, average exposure of 31,800 MWD/MTHM (peak of 33,000 MWD/MTHM)
- From BWRs average exposure of 25,300 MWD/MTHM (peak of 26,000 MWD/MTHM)
- For total input, average total exposure of 29,300 MWD/MTHM Spent Fuel

Out-of-Reactor Time prior to FRP input:

- Minimum of 90 days prior to receipt at FRP
- Minimum of 1.5 years before reprocessing at FRP[a]

FRP Reprocessing Capacity (in MT of Spent Fuel)

- 1,500 MT/yr (30-yr lifetime)[a] average capacity
- 5 MT/day peak capacity

Products of Reprocessing

- Uranyl nitrate solution (converted to UF_6 for shipment from FRP to burial grounds)
- Plutonium nitrate solution (converted to PuO_2 for shipment from FRP to burial grounds)[a]

Wastes Resulting from Reprocessing

- High-Level and intermediate-level wastes stored on an interim basis as liquids in underground tanks.

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[a] Processing characteristics listed are different from those postulated for near-term operation of BNFP. The information presented is currently expected to be representative of long-term operating characteristics at a plant such as BNFP.

- High and intermediate level liquid wastes converted within 5 years to a vitrified solid and shipped offsite to a Federal repository.

- Fuel cladding hulls, failed equipment and other solid wastes stored onsite on an interim basis in concrete or stainless steel containers in engineered underground storage prior to shipment offsite for disposal.

Effluents from Reprocessing During Normal Operation

- Gases (only routine radioactive effluents are indicated):
  - ^{85}Kr disharged up main stack (100 meters tall).
  - Majority of tritium and ^{14}C discharged to main stack.
  - Excess water discharged up main stack as vapor.
- Heat rejected to cooling tower via closed loop heat exchangers.
- Process liquid wastes with low contamination diluted and discharged to river.

9.1.3 Estimates of Radioactivity Levels at FRP shutdown

Estimates of radioactivity levels in the reference fuel reprocessing plant after reprocessing operations have been terminated (all spent fuel removed) and final operational cleanout flushings of the process areas have been completed are summarized in Reference 1.

9.2 Fuel Reprocessing Plant Decommissioning Experience

To date, there has been no experience in the decommissioning of a commercial FRP. Federal facilities at the Hanford, Savannah River, and Oak Ridge sites that have been involved with the reprocessing of irradiated fuels have been decontaminated and their equipment disassembled.[2] A substantial amount of this information is directly relatable to decontamination of future fuel reprocessing plants.

The Nuclear Fuel Services (NFS) plant in West Valley, New York, is the only commercial reprocessing plant that has operated in the United States (although it is not currently operating). The NFS situation is not directly translatable to the present or projected nuclear power industry because a national policy (10 CFR 50, Appendix F) requiring the solidification of high-level waste was not established until 1971, well after the plant began operation. Therefore, since NFS has its reprocessing high-level wastes stored in large underground tanks in slurry form (similar to the practices followed at the Hanford and Savannah River sites), the costs of decommissioning this plant are expected to be higher than that of newer FRPs.

9.3 Decommissioning Alternatives

Once a fuel reprocessing plant has reached the end of its useful operating life, it must be decommissioned. As discussed in Section 2.3 this means safely removing the facility from service and disposing of all radioactive materials in excess of levels which would permit unrestricted use of the property. Alternatives considered here as to their potential for satisfying this general requirement for decommissioning include DECON and SAFSTOR (passive SAFSTOR and custodial SAFSTOR). ENTOMB is not considered a viable option because of long-lived transuranics present in the entombed structure resulting in radiation exposure which does not decrease with time. The disposition of the nonradioactive buildings and facilities is left to the discretion of the facility owner and is not part of the decommissioning procedure. This section discusses the decommissioning alternatives evaluated for the FRP.

9.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use as early as the 5 years estimated for decommissioning after the end of facility operation.

DECON is advantageous because it allows for termination of the NRC license within a relatively few years after cessation of facility operations and removes a radioactive site. DECON is advantageous if the site is required for other purposes, if the site is extremely valuable, or, if for some reason the site must be immediately released for unrestricted use. It is also advantageous in that the facility operating staff is available to assist with decommissioning and that continued surveillance is not required. An important disadvantage is the higher occupational radiation dose which occurs during DECON compared to the SAFSTOR alternative.

Three important radiation exposure pathways need to be considered in the evaluation of the radiation safety of normal FRP decommissioning operations: Inhalation, ingestion, and external exposure to radioactive materials. For reasons similar to those discussed for PWRs in Section 4.3.1, during decommissioning the dominant exposure pathway to workers is external exposure while for the public the dominant exposure pathway is inhalation. During the transport of radioactive waste, the dominant exposure pathway is external exposure for both transportation workers and the public. A summary of the doses resulting from these pathways is presented in Table 9.3-2.

Occupational Radiation Dose

The occupational radiation dose from external exposure to radioactive materials, not including transportation of radioactive waste, is estimated to be about 512 man-rem over the 5 year period of DECON. Occupational radiation doses were calculated by PNL from estimated radiation levels in the various areas of the reference FRP and from man-hour estimates for performing the decontamination operations. Table 9.3-2 gives the estimated occupational external radiation exposure for DECON.

The reference FRP was designed to store high-level liquid waste (HLLW) for five years prior to solidification and then to store the solidified waste five years prior to shipment to a federal waste repository. It is expected that any future FRPs would be designed to solidify the HLLW continuously within the process building, and store only solidified waste. Therefore, future plants would use a few smaller tanks instead of the large underground HLLW storage tanks and separate waste solidification plant. This would reduce the decommissioning occupational radiation exposure and costs by between 40 to 50 percent.

Table 9.3-2 Summary of radiation safety analysis for decommissioning the reference FRP (Man-rem)

	DECON	SAFSTOR (Passive)				SAFSTOR Custodial)			
		10 Years	30 Years	100 Years	200 Years	10 Years	30 Years	100 Years	200 Years
Occupational Safety									
Decontamination Operations	512	426[a]	296[a]	124[a]	~85[a]	423[a]	290[a]	113[a]	~73[a]
Transportation	20	17	12	5	~1	17	12	5	<2
Continuing Care		2	4	9	14	13	31	61	78
Total Occupational Exposure	532	445	312	138	~100	453	333	179	~153
Public Safety[b]									
Decontamination Operations	10	8	5	2	<1	8	5	2	<1
Transportation	9	7	5	2	<1	7	5	2	<1
Continuing Care	--	neg.[c]	neg.[c]	neg.[c]	neg.[c]	neg.[c]	neg.[c]	neg.[c]	neg.[c]
Total Public Exposure	19	15	10	4	<2	15	10	4	<2

(a) The radiation exposures for the preparation for passive and custodial safe storage are 81 and 69 man-rems, respectively and are included in the expsoures for Decontamination Operations.

(b) Radiation doses from postulated accidents are not included.

(c) Neg. = negligible. Radiation doses to the public from normal continuing care activities are not analyzed in detail, but are expected to be significantly smaller than those from decontamination operations.

Public Radiation Dose

The inhalation radiation dose to the public resulting from radionuclide releases during DECON, not including doses during transportation of radioactive waste, is estimated to be 10.2 man-rem (50-year population dose commitment to the whole-body). This radiation dose is very small compared to the background radiation exposure normally received by members of the public. Details of the methods used for calculation of doses are found in Reference 1.

Public Radiation Dose from Postulated Accidents During DECON

DECON procedures were examined and potential accidents postulated that could lead to the release of radioactive materials. The largest radiation dose to the maximum-exposed individual from a postulated accident during DECON is the failure of the ventilation system HEPA filter during chemical decontamination of the high-level waste tank. Approximately 60 mCi of radioactivity are assumed to be released directly to the atmosphere. This release results in a maximum annual dose in the first year of 15 mrem to the lung and a 50-year dose commitment of 160 mrem to the bone of the maximum-exposed individual.

Transportation Safety During DECON

Radioactive waste generated during the decontamination of an FRP must be packaged and shipped according to prescribed federal regulations to an offsite repository. These wastes include transuranic (TRU) wastes that are shipped by rail to a Federal repository and non-TRU wastes that are shipped by truck to a commercial shallow-land burial ground. A summary of the wastes generated and shipped is given in Table 9.3-1.

Table 9.3-1 Packaging and shipping information for wastes generated from DECON[a]

Shipping Method	Volume, m^3	Weight, kg	Number of Containers	Number of Shipments
Rail (TRU wastes)	4,600	3.7×10^6	3,200	180
Truck (non-TRU) wastes)	3,100	2.3×10^6	2,500	160

[a] Initial chemical decontamination wastes account for approximately 5% of the total volume, 9% of the total shipments, and 99.9% of the total radioactivity

The estimated radiation doses due to external exposure from rail and truck transport of radioactive waste are 20 man-rem to the transportation workers and 9 man-rem to the public.

The release of radioactive material from transportation accidents is estimated to be small. The more probable transportation accidents result in no release or one that is very small. For a severe truck accident, a hypothetical maximum-exposed individual located 100 meters away is estimated to receive a 50-year dose commitment to the bone of 11 rem; however, this type of accident has a very low probability of occurrence.

9.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a FRP in such condition that the risk to safety is within acceptable bounds and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

Generally, the purpose of SAFSTOR is to permit residual radioactivity levels to decay to levels that will reduce occupational radiation exposure during decontamination. As indicated in Table 9.3-2 most of the occupational dose reduction due to decay occurs during the first 100 years after shutdown with less dose reduction thereafter. The public dose which is small to begin with, also experiences most of its reduction during the first 100 years. Hence, in contrast to DECON, to take advantage of this dose reduction, the safe storage period could be as long as 30 to 100 years. The end result is the same as for DECON: release of the site and any remaining structures for unrestricted use.

SAFSTOR is advantageous in that it results in reduced occupational radiation exposure in situations where overriding land use considerations do not exist. Disadvantages are that the licensee is required to maintain a possession only license and to meet its requirements at all times during safe storage thus contributing to the number of sites dedicated to radioactive confinement for an extended time period. Other disadvantages are that surveillance is required, that dollar costs are higher than for DECON, and that experienced operating staff may not be available at the end of the safe storage period to assist in the deferred decontamination.

The several subcategories of SAFSTOR are given in Section 2.3.2. They are discussed in detail here as they pertain to FRP decommissioning.

Preparation for Safe Storage

Custodial SAFSTOR requires a minimum cleanup and decontamination effort during preparation for safe storage, followed by a period of continuing care with the active protection systems (principally the ventilation system) kept in service throughout the storage period. Safe storage preparation procedures for passive (i.e., hardened) safe storage are the same as those for custodial safe storage, with the exception of the following additional activities:

- sealing all entrances to the radioactive portions of the facility, using welding techniques

- deactivating the ventilation systems
- deactivating all cranes and viewing windows

Hardened safe storage requires slightly more extensive sealing of the structures than passive safe storage: however, the cost increase is estimated to be small. Thus, passive and hardened SAFSTOR are considered the same for this assessment.

The occupational radiation doses from passive and custodial safe storage preparation, not including transportation, are estimated to be 81 and 69 man-rem, respectively, and are given in Table 9.3-2. The extra labor to prepare for passive storage results in the slightly higher dose.

The estimated inhalation radiation doses to the public from the release of radionuclides during both passive and custodial safe storage preparation are estimated to be 0.006 man-rem (bone dose) to the population. This dose is much below natural background radiation exposure.

The maximum postulated accident for passive and custodial safe storage preparation is a fire in the ventilation system resulting in a maximum annual lung dose in the first year of 0.006 mrem and a 50-year lung dose commitment of 0.008 mrem.

Estimated routine radiation doses from rail and truck transport of radioactive wastes from either passive or custodial storage preparations are 3 man-rem to transportation workers and 1.4 man-rem to the general public.

Safe Storage (Continuing Care)

Following completion of safe storage preparation, the facility is placed in a period of safe storage (continuing care). This safe storage consists of surveillance and maintenance, designed to ensure that the facility remains in a condition that poses minimum risks to the public. This phase includes routine inspections, preventive and corrective maintenance on operating equipment, and a regular program of radiation, effluent, and environmental monitoring. The status of all safety-related equipment is monitored throughout the continuing care period. Passive and custodial continuing care doses are listed in Table 9.3-2.

The release of radionuclides from accidents during the continuing care period is negligible. The combination of the low probability of the initiating events and the immobility of the FRP radionuclide inventory minimizes the effect of potential accidents during this period.

Deferred Decontamination

Deferred decontamination to residual levels permitting unrestricted use of the facility takes place after a number of years of safe storage. This decontamination is more thorough than the preliminary decontamination which was a part of the preparations for safe storage. The decontamination procedures are essentially the same following each of the different SAFSTOR modes; however, the steps necessary following passive safe storage are more extensive. The additional activities include:

- removal of entrance barriers to contaminated areas
- reactivation of utilities, cranes, and manipulators
- installation of filters and reactivation of the ventilation systems.

The principal advantage of deferred decontamination is that radioactive decay takes place during the continuing care period. Table 9.3-2 shows that decontamination at a deferred time reduces the occupational radiation exposure by a substantial amount. Deferred decontamination would also reduce the radiation dose commitment for public exposure as shown in Table 9.3-2.

The radiation dose from transportation for deferred decontamination for both public and occupational exposures is expected to decrease because of radionuclide decay and also because of a reduction in materials needing transportation. A 100-year delay would result in a radiation dose reduction of about 75%. These doses are shown in Table 9.3-2.

9.3.3 Site Decommissioning

The residual contamination of the FRP site resulting from past operation and subsequent decommissioning is expected to be very low. This is as a result of continuous site surveys and the immediate removal of any contamination found during the life of the facility. Site cleanup is expected to be minimal, however, this will be confirmed by the radiation survey.

9.3.4 Summary of Radiation Safety

An advantage of DECON is that it results in the release of the site for unrestricted use within about 5 years after shutdown of plant operations. However, DECON has higher estimated occupational radiation exposure (512 man-rems) than the other alternatives. Depending on the length of the continuing care period, both passive and custodial SAFSTOR can result in an occupational dose reduction the magnitude of which is considered to be of marginal significance in terms of health and safety (see Table 9.3.2).

As shown in Table 9.3-2, radiation doses to the public from decommissioning operations and transportation of contaminated materials are all low, with a maximum of 20 man-rem due to DECON. The maximum postulated accident is estimated to give the maximum-exposed member of the public a 50-year dose commitment of 8.8 rem.

In summary, the radiation dose to the public is estimated to be quite low and to have little impact compared to natural background radiation. For decommissioning workers, DECON results in larger radiological impact than the other alternatives. Reductions in this dose can be brought about by use of 30-year or 100-year SAFSTOR.

9.3.6 Decommissioning Costs

An estimate of the costs of decommissioning the FRP by each of the principal alternatives is presented below. These costs are summarized and compared in Section 9.3.6.2.

9.3.6.1 Detailed Costs

Reference 1 presents a discussion of decommissioning costs and their bases. Costs are included for 1) direct labor and subcontractor activities, 2) equipment and materials, 3) packaging, transportation, and disposal of contaminated waste, and 4) utilities, services, and other overheads. The details presented in Reference 1 include breakdowns for support staff labor, decommissioning worker labor, subcontractor activities, equipment and materials, shipping, waste disposal and utilities and taxes.

The basic cost estimates presented assume relatively efficient performance of the decommissioning activities. A 25% contingency is added to the cost estimate totals as an allowance for unforeseen problems or scheduling delays that may arise during the decommissioning.

9.3.6.2 Summary of Costs

Table 9.3-4 summarizes the estimated costs in 1986 dollars for the decommissioning alternatives. As shown in the table, the costs for SAFSTOR are greater than the cost for DECON. All SAFSTOR modes increase in cost with increasing years of continuing care. The continuing care cost following preparation for custodial and passive safe storage are estimated to be $1.05 million and $262,200 per year, respectively. Costs for deferred decontamination after custodial and passive safe storage are estimated to be about $130 million.

Deferred decontamination is a comparatively large cost because it requires additional costs to refurbish auxiliary facilities, to reinstitute a trained decommissioning organization, and to provide a new safety analysis and an additional license application. Other costs of deferred decontamination are lower than for DECON due to the decay of much of the radioactivity. As can be seen from Table 9.3-4, continuing care costs become more significant with time.

Waste management costs represent about two-thirds of the total cost for decontamination of the reference FRP. Waste disposal costs for transuranic wastes, in turn, represent about 85% of the waste management costs. Since waste disposal costs are based on the volume of material placed in the deep geologic repository, reducing waste volumes has a significant effect in reducing decommissioning costs. Significant economic incentives exist to develop volume reduction techniques. For example, extensive use of electropolishing, which has the potential to decontaminate metallic wastes to possibly releasable radioactive contamination levels or to levels that permit their disposal in shallow-land burial grounds, may offer cost reductions.

Decontamination of the liquid waste storage system represents about one-third of the total decontamination costs. Alternative reprocessing plant designs might not employ large liquid waste storage systems. These designs would have a significant decommissioning cost advantage (40 to 50%) over the design of the reference plant.

Table 9.3.4 Summary of estimated costs for decommissioning a fuel reprocessing plant (1986 $ millions)

Item	DECON	SAFSTOR (passive)				SAFSTOR (custodial)			
		10 Years	30 Years	100 Years	200 Years	10 Years	30 Years	100 Years	200 Years
Initial Decommissioning	168.6	46.6	46.6	46.6	46.6	44.3	44.3	44.3	44.3
Continuing Care	--	1.9	7.1	25.7	51.7	8.0	29.0	102.5	207.5
Deferred Decontamination	--	132.9	132.9	132.9	132.9	131.7	131.7	131.7	131.7
Total Costs (rounded)	169	181	187	205	231	184	205	278	384

It is assumed that radioactive contamination levels on the site from routine releases during facility operation do not require extensive site cleanup operations during decommissioning to meet the limits for release of the FRP for unrestricted use. A preliminary estimate of the costs to perform these activities, should they be required, is $100,000. This would not appreciably change the decommissioning cost totals presented in Table 9.3-4.

9.4 Environmental Consequences

The decommissioning of an FRP will have few negative environmental consequences. By definition, the decommissioning of any nuclear facility is the removal of radioactive material to levels which are low enough to permit the facility to be released for unrestricted use. The decommissioning alternative to be chosen depends to a large extent on the radiation dose and cost evaluations, on desired future use of the site, and on the time period involved.

The summaries of radiation safety and decommissioning cost analyses are given in Sections 9.3.5 and 9.3.6, respectively.

Demolition of remaining buildings (assuming prior decontamination to a level permitting unrestricted use of the FRP) is an optional owner and/or local government choice. Its major environmental impact on the surrounding population will be the resulting increase in noise level within the immediate vicinity of the plant (about 1 mile), primarily because of the use of explosives. However, most of this noise will be generated within the process building and will be muffled by the building until the final removal of the building shell.

9.4.1 Wastes

The management of wastes (i.e., vitrified, chemical decontamination solutions, contaminated equipment and materials, and contaminated trash) resulting from decommissioning is an important factor in the cost and environmental impact of decommissioning. The large volumes of waste generated during DECON, as shown in Table 9.4-1, require a large expenditure of money and energy. Complete decontamination of an FRP requires about 0.4 hectare (1 acre) of land for final storage of the contaminated materials removed from the site. The high-level

Table 9.4-1 Radioactive wastes resulting from decommissioning a reference FRP

	DECON		Passive SAFSTOR[a]		Custodial SAFSTOR[a]	
Disposition of waste	Volume, m^3	Disposal Cost, Millions of $	Volume, m^3	Disposal Cost, Millions of $	Volume, m^3	Disposl Cost, Millions of $
TRU-Waste	4,600	86.8	210	20.9	210	20.9
non-TRU wastes	3,100	4.1	180	0.2	180	0.2
Totals	7,700	90.9	390	21.1	390	21.1

(a) Does not include deferred decontamination.

radioactive and TRU wastes will require about 4,600 m^3 in an expensive deep geologic disposal facility. This is equivalent to 163,500 cubic feet mined from either salt or basalt. The low-level and non-TRU wastes will require about 0.16 hectares (0.4 acre) of shallow-land burial area. These are considered irretrievable uses of land.

The volumes of waste for both passive and custodial safe storage represent the preparation state only. Deferred decontamination wastes increase each of these to values nearly that of DECON. However, although the overall waste volume may remain nearly constant, the amount sent to geologic storage will decrease with time, while shallow-land burial volumes will increase. For example, if the continuing care period were extended for 100 years, there would be a reduction in radioactivity and thus the total amount of waste to be disposed of to repositories would shift from deep geologic storage to shallow-land burial. These changes could result in a substantial change of costs and repository use.

The decommissioning of an FRP to levels which permit unrestricted use of the facility makes about 473 hectares (1,160 acres) of land available for reuse. The value recovered from decommissioning depends on the value of the reclaimed land and the need the owner has for such property during the time period under consideration.

If the plant site of about 20.4 hectares (50 acres) is restored to its original native condition, it will increase the natural habitat for flora and fauna by a relatively small amount. This is a favorable environmental impact, but one that is relatively insignificant.

An additional effect of decommissioning is that the decontamination of an FRP will require the use of expendable tools and materials that will be discarded as waste.

9.4.2 Nonradiological Safety Impacts

The nonradiological hazards involved in the decommissioning of an FRP were reviewed on the basis of hazards to be found in both the chemical and construction industries. These estimates are calculated to be conservative.

Potential chemical pollutants that could be released during the various decommissioning alternatives were examined and found to be insignificant. The small quantities of hazardous chemicals used and the low likelihood of their dispersal into the environs indicate that potential chemical pollutants from decommissioning operations do not pose a significant public hazard.

The potential lost-time injuries and fatalities are based on AEC/DOE operations data. Table 9.4-2, gives the lost-time injuries and the fatalities estimated for each decommissioning mode. The maximum potential for lost-time injuries and fatalities (1.9 and 0.01, respectively) is during the decontamination operations when the maximum amount of heavy equipment is being removed from its position, cut, boxed, and shipped to appropriate storage.

9.4.3 Socioeconomic Impacts

The major societal impacts occur prior to decommissioning with the shutdown of the plant. The shutdown of the plant and DECON will reduce the work force from

Table 9.4.2 Summary of nonradiological safety impacts

Type of Safety Concern	Source of Safety Concern	Units	DECON	SAFSTOR (Passive)				SAFSTOR (Custodial)				ENTOMB
				10 Years	30 Years	100 Years	200 Years	10 Years	30 Years	100 Years	200 Years	
Serious Lost-Time Injuries[a]	Decommissioning											
	Operations	no./mode	1.7	1.9	1.9	1.9	1.9	1.75	1.75	1.75	1.75	0.85
	Transportation	no./mode	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.10
	Continuing Care	no./mode	--	0.083	0.26	0.83	1.6	0.40	1.2	4.0	8.0	--
Fatalities[a]	Decommissioning											
	Operations	no./mode	0.0091	0.010	0.010	0.010	0.010	0.0096	0.0096	0.0096	0.0096	0.005
	Transportation	no./mode	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.007
	Continuing Care	no./mode	--	0.0008	0.0024	0.0081	0.016	0.038	0.012	0.038	0.076	--

(a) Estimates of lost-time accidents and fatalities for either passive or custodial safe storage preparation are 0.3 and 0.003, respectively. The transportation estimates of lost-time accidents and fatalities for either passive or custodial safe storage preparation are 0.03 and 0.002, respectively.

about 300 to 50 people over about a 2-year period and the 50 person decommissioning force will be reduced to near zero in 3 to 6 years. Thus, the total reduction in force will take place over a minimum period of 5 years and this should tend to mitigate the adverse impact of loss of jobs and income to the regional community. Since the planning stage preceding the shutdown will require about two years, the community will have an additional two years to plan for the reduction in jobs. Therefore, the impact from job loss (income loss of about $4 to $5 million annually) due to plant shutdown will be small because of the period of time for the action to take place. Decommissioning tends to mitigate the impacts due to plant shutdown.

Tax revenues will also be lost to the local communities and to the state, but here again, the impact is spread over a period of time and as employment reduces and people leave the area, public services will also reduce. Thus, decommissioning tends to mitigate the impacts of plant shutdown.

9.5 Comparison of Decommissioning Alternatives

Primary parameters that affect the selection of a decommissioning alternative are the radiation doses and the economic costs. These are summarized in Tables 9.3-2 and 9.3-4.

Advantages of DECON are that the site and facility can be released for unrestricted use 5 years after the shutdown of the plant and that the cost for DECON is less than for SAFSTOR, and therefore, DECON is considered to be a preferable alternative since occupational dose reduction by SAFSTOR is of an amount considered of marginal significance to health and safety. Both 30-year SAFSTOR and 100-year SAFSTOR may be reasonable options for reducing occupational exposure since additional radioactive decay occurs after 30 years. In 100-year SAFSTOR, the occupational dose rates have decayed to about 30% of DECON and the costs, although increased by 20% over the 100-year period are still reasonable when evaluated against the reduced occupational dose.

REFERENCES*

1. K. J. Schneider and C. E. Jenkins, Technology, Safety, and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant, NUREG-0278, Vols. 1 and 2, Prepared by Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, October 1977.

2. G J. Konzek and C. R. Sample, Decommissioning of Nuclear Facilities--An Annotated Bibliography, NUREG/CR-0131, Prepared by Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, October 1978.

*See footnote to reference in Chapter 1 for document purchasing availability.

10 SMALL MIXED OXIDE FUEL FABRICATION PLANT

A small mixed oxide (MOX) fuel fabrication plant is a manufacturing facility designed and constructed for the production of $(U\text{-}Pu)O_2$ pellets and incorporation of these pellets into clad fuel rods. The plant also has facilities for the recovery of plutonium from unirradiated scrap materials. This section considers the environmental consequences of decommissioning a small MOX plant.

This section is based primarily on a detailed study[1] of the decommissioning of a small mixed oxide fuel fabrication plant. In this study PNL selected the Cimarron Plutonium Facility located near Crescent, Oklahoma as the reference MOX plant and assumed it to be located at the generic site. The generic site is described in Section 3.1. Although not currently operating, Cimarron is considered to have characteristics related to many of the existing small MOX plants. Some operational features were added to this study to make it applicable to plants using other processes. PNL then developed and reported information on the available technology, safety considerations, and probable costs for decommissioning the reference facility at the end of its operating life.

10.1 Description of the Reference MOX Fuel Fabrication Plant

The reference plant is assumed to have operated for 10 years at a production rate of 2 MT of heavy metals per year. The feed to the plant can be either the oxide powders or nitrate solutions of plutonium and uranium. The plant operation is assumed to involve either mechanical blending of the oxide powders or coprecipitation of the solutions, using ammonia. The plant consists of a single building with a floor space of 2400 m^2 that also contains offices, laboratories, and maintenance shops. Auxiliary facilities are a cooling tower, an electrical substation, effluent storage, and a gas supply. Processes include solvent extraction, ion exchange, and oxalate precipitation for recovery of dirty scrap, and a two-stage liquid waste evaporation system followed by concreting of liquid wastes. The plant uses small, criticality safe vessels located in numerous glove boxes distributed throughout nine rooms. Operation of most steps is on a batch basis.

The generic site (Section 3.1) for this plant is located in a rural area. The site occupies 470 hectares (1,160 acres) in a rectangular shape of 2 km (1.24 miles) by 2.35 km (1.46 miles). A moderate-size river runs through one corner of the site. The use of any part of this site for anything besides the MOX plant is prohibited. The plant is in a restricted area of about 1.2 hectares (3 acres) within the site.

As a part of the plant operations, it is assumed that a final inventory cleanout has been performed that included disposal of process materials, chemicals, trash, scrap, scrap solutions, and contaminated solutions. Empty product, scrap, and waste handling tanks have been flushed of remaining process solutions. The dominant remaining radionuclides that will contribute to organ doses are ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{241}Am. About 23 kg of plutonium are estimated to remain in the process building following the final inventory cleanout.

10.2 MOX Decommissioning Experience

No direct experience exists in the decommissioning of licensed MOX fuel fabrication facilities because existing plants, which are not now operating, are being held in a standby or storage status. However, several government-owned plutonium fabrication facilities have been decontaminated. In all cases, the buildings still stand and contain radioactive contamination above unrestricted levels. Some are closed and sealed but others have been converted to new, related facilities involving the use of radioactive materials.

A list of these facilities, and a detailed discussion of decommissioning steps taken at two of them appear in Reference 1. This report also contains a discussion of lessons learned from decommissioning experiences.

10.3 Decommissioning Alternatives

Once a MOX plant has reached the end of its useful operating life it must be decommissioned. As discussed in Section 2.3, this means safely removing the facility from service and disposing all radioactive materials in excess of levels which would permit unrestricted use of the facility. Several alternatives are considered here as to their potential for satisfying this general requirement for decommissioning. The decommissioning alternatives considered and discussed here are DECON, SAFSTOR (custodial), and ENTOMB. Radiological effects and costs of each alternative are also discussed. After the radioactive inventory has been removed down to levels permitting unrestricted use of the facility and the contaminated equipment and structures decontaminated, demolition of the building would be left as an owner option.

The alternative used depends on such considerations as dose, cost, proposed use of the site, and desirability of terminating the license. A special consideration for decommissioning MOX plants is the half-lives of the radionuclides present in the facility. The radionuclides processed in a MOX plant are received from a reprocessing plant. Those radionuclides include plutonium and uranium and their decay products, but not fission products. There are several isotopes of these actinides, and the radioactivity of these isotopes is very high, particularly that of the plutonium. These isotopes have such long half-lives that it is apparent that deferred decontamination for 10 or even 100 years would not result in reduced radiation doses to decommissioning personnel and, therefore, SAFSTOR would not appear to be a reasonable alternative without some other justification.

Safeguards will be required during each decommissioning alternative for protection of the public. Security is assumed to be similar to that needed during plant operation but on a smaller scale.

10.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use as early as the 5 years estimated for decommissioning after the end of facility operation.

DECON is advantageous because it allows for termination of the NRC license within relatively few years after cessation of facility operations and removes a radioactive site. DECON is advantageous if the site is required for other purposes, if the site is extremely valuable, or, if for some reason the site must be immediately released for unrestricted use. It is also advantageous in that the facility operating staff is available to assist with decommissioning and that continued surveillance is not required.

The first step toward DECON is planning and preparation, which is initiated during the last 2 years of normal plant operation. During this time, detailed plans and procedures are prepared, a decommissioning staff is trained, safety and environmental impact reports are prepared if necessary, and effluent control systems modifications are started.

When the actual decommissioning work begins following shutdown, chemical decontamination of the wet process areas and physical cleanout of the dry process areas are started first. Physical decontamination of most plant areas proceeds next. Chemical decontamination involves flushing of internal surfaces of process piping and equipment, followed by spraying with chemical solutions the external surfaces of process equipment, piping, and internal surfaces of glove boxes.

Physical decontamination involves disassembly of equipment and enclosures and removal of the resulting materials. Physical decontamination also involves removal of contaminated parts of structural materials. These are packaged and transported offsite as waste, either as is or after chemical decontamination to remove bulk quantities of radionuclides. For DECON, disassembly and removal of equipment in some of the cleaner areas starts about 2 months after shutdown, and proceeds in parallel with chemical decontamination of other areas. The facility and service systems are removed as the last steps. At this point, the facility should be at or below acceptable levels of residual radioactivity and could be considered to be decommissioned. However, it may be desirable for nonradioactive reasons to remove the buildings, in which case the final phase would be demolition and restoration.

If demolition and restoration were used, all above grade portions of structures could be demolished using conventional methods such as explosives and impact balls. The site could then be graded and planted with vegetation to near pre-facility conditions.

Analyses of radiation exposures and costs for DECON are presented in Section 10.3.4.

10.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a MOX plant in such condition that the risk to safety is within acceptable bounds, and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

Generally, the primary purpose of SAFSTOR for most nuclear facilities is that it results in reduced occupational exposure compared to DECON. However, for the reasons given in Section 8.3 and as can be seen in Table 10.3-1 this is not necessarily the case for MOX plants. SAFSTOR could be advantageous in situations where there are overriding land use considerations. However, in addition to increased radiation exposure other disadvantages are that the licensee is required to maintain a material license and to meet its requirements at all times during safe storage thus contributing to the number of sites dedicated to radioactive confinement for an extended time period. Other disadvantages are that surveillance is required, the dollar costs are higher than for DECON, and the experienced operating staff may not be available at the end of the safe storage period to assist in the deferred decontamination.

Chemical and physical decontamination activities in preparation for custodial safe storage are similar to those performed for DECON, except that for custodial safe storage, initial decontamination is generally done to the point that loose radioactivity is removed.

Preparations for the continuing care period of custodial safe storage involve deactivation and isolation of contaminated areas, sealing of contamination by adding durable seals or covering with paint, refurbishing the plant ventilation system, and installing improved alarm and protection systems for fire, intrusion, or malfunctioning equipment.

Continuing care activities may include operation of the facility ventilation system, routine inspection, corrective and preventive maintenance of the ventilation and other safety systems, environmental surveillance, and prevention of unneeded intrusion by man.

For the MOX facility, custodial safe storage is terminated eventually by deferred decontamination to levels permitting unrestricted use of the facility. For this action, activities are generally similar to those for DECON, with allowances for the prior decontamination efforts and retraining of new decommissioning staff.

Analyses of radiation exposures and costs for SAFSTOR are provided in Section 10.3.4.

10.3.3 ENTOMB

The ENTOMB alternative requires use of a structure to hold or confine the radioactivity until such time as it has decayed to levels which permit release of the facility for unrestricted use. ENTOMB would involve the encasement in concrete of heavily contaminated rooms within the reference MOX facility which would prevent the escape of radioactivity and prevent deliberate or inadvertent intrusion. The length of time the integrity of the entombing structure must be maintained depends on the inventory of radionuclides present.

The MOX plant will still contain the 23 kg of plutonium estimated to remain in the process building following final inventory cleanout at shutdown, (see Section 10.1) including ^{239}Pu with a half-life of 24,390 years, and the entombed structure would in effect become a new surface high-level waste disposal site. This would be an undesirable situation in that it would be contributing to the problems associated with increased numbers of waste disposal sites. Moreover, the entombed structure would require surveillance in perpetuity which is well beyond the time that the required institutional control could be expected to be effective (approximately 100 years is considered to be consistent with recommended EPA policy on reliance on institutional control of radioactivity confinement). Although the ENTOMB option does not appear viable for the reasons given, it will be discussed for comparative perspective with the other options.

10.3.4 Summary of Radiation Safety and Decommissioning Costs

Each of the decommissioning alternatives has associated with it unavoidable radiation exposures, accident potential, and costs. As is seen from Table 10.3-1 none of these is appreciably reduced with time. This conclusion might change if technologies improve the reduction of accidental releases of radioactivity or the cost-efficiency of decontaminating the equipment.

10.3.4.1 Radiation Safety

Radiation safety for MOX plant decommissioning is discussed in detail in Reference 1. Dose calculations were based on maximum releases of radioactivity to maximize the consequences and thus present worst-case evaluations.

Occupational radiation exposure of workers performing the decommissioning activities results from external exposure to surface contamination for reasons similar to that discussed for PWRs in Section 4.3.1. Dose calculations are based on the estimated radiation levels in various areas of the plant and the estimated labor requirements for decommissioning each of those areas. Many of the radionuclides remaining in a MOX plant after shutdown have long half-lives. Generally, preparation for safe storage does not involve extensive decontamination of these radionuclides. Because the half-lives of these radionuclides are long compared to the time that the facility might be held in safe storage awaiting deferred decontamination, the occupational radiation exposures will not decrease as a result of using the SAFSTOR alternative. There will be a shift in nuclide content from ^{241}Pu to ^{241}Am while a plant is in continuing care, but this shift will be insignificant. In calculating the total doses received, there are additional exposures incurred under the custodial safe storage mode that must be considered. These are shown in Table 10.3-1, which is a summary of the radiation exposures that may result from each of the decommissioning alternatives. It is to be noted again that the reference MOX plant for which the calculations were made is a small MOX plant.

The dominant radiation exposure pathway to members of the public during decommissioning operations is inhalation of airborne radionuclides for reasons similar to those discussed for PWRs in Section 4.3.1. Emissions may result from either routine decommissioning activities or from potential accidental releases. Total estimated public exposures during routine decommissioning activities are small, as shown in Table 10.3-1.

A wide range of possible accidents that would result in released radioactivity is postulated. The largest releases are from failure of HEPA filters, cutting of contaminated metal, and explosion and/or fire in the ion exchange resins. These would result in the same quantities of release and radiation doses and have the same probabilities of occurrence with either decontamination alternative. A summary of the estimated doses to the public from accidents is shown in Table 10.3-2. The major postulated accident is the release of contaminated dust from an exhaust duct by failure of a HEPA filter. Radiation doses to the public resulting from accidents are low enough to be insignificant. Even with

Table 10.3-1 Summary of Radiation Safety Analyses for Routine Decommissioning of the Reference MOX Plant man-rem)[a]

Occupational Exposure	DECON	SAFSTOR 10 Years	SAFSTOR 30 Years	ENTOMB
Preparation	NA	23	23	9.4
Continuing Care	NA	64	206	neg
Decontamination[b]	70	70	70	NA
Transportation	6.4	8	8	0.6
Totals	76	165	307	10
Public Exposure (50-year dose commitment to critical organ)				
Preparation	NA	0.1	0.1	0.10
Continuing Care	NA	0.05	0.1	neg.
Decontamination[b]	2.2	2.2	2.2	NA
Transportation	1.5	1.9	1.9	0.15
Totals	3.7	4.3	4.3	0.25

(a) Adapted from Reference 1.

(b) For SAFSTOR, this is deferred decontamination.

Table 10.3.2 Summary of radiation doses to the maximum-exposed individual from accidental airborne radionuclide releases during decommissioning activities[(a)]

Incident	Release to Atmosphere (μCi)	First-Year Dose, mrem		Fifty-Year Dose Commitment, mrem		Expected Frequency of Occurrence[(b)]
		Bone	Lung	Bone	Lung	
Loss of Intermediate-Stage HEPA Filter After Exhaust Duct Decontamination	1.0×10^4	5.2	32	1.1×10^2	78	High
Inadvertent Cutting of Undecontaminated Metal	1.6×10^2	8.5×10^{-3}	5.0	1.8	1.3	High
Explosion and/or Fire of Ion Exchange Resin	83	7.0×10^{-2}	6.6×10^{-2}	2.5	7.0×10^{-2}	Medium
Inadvertent Dumping of Contaminated Solid Wastes:						
Abraded Firebrick	14	7.4×10^{-4}	4.4×10^{-2}	1.5	1.1	High
Concrete Dust	1.4	7.4×10^{-5}	4.4×10^{-3}	1.5×10^{-2}	1.1×10^{-2}	High
Condensed Metal Vapor	7.0×10^{-2}	3.8×10^{-6}	2.2×10^{-4}	7.9×10^{-4}	5.7×10^{-4}	High
Loss of Local Airborne Contamination Control/Loss of Vacuum Filter	3.5	1.9×10^{-4}	1.1×10^{-2}	3.8×10^{-2}	2.8×10^{-2}	High
Temporary Loss of Services: Electricity (Normal and Emergency)	1.4	7.4×10^{-5}	4.4×10^{-3}	1.5×10^{-2}	1.1×10^{-2}	Medium
Liquid Leak:						
Chemical Decontamination	16	1.4×10^{-2}	4.8	1.3×10^{-2}	1.4×10^{-2}	High
Electropolishing	2.8×10^{-2}	5.4×10^{-6}	5.1×10^{-6}	1.9×10^{-4}	5.1×10^{-6}	Medium
Fire Involving Contaminated Clothing or Cumbustible Waste	0.11	9.6×10^{-5}	9.2×10^{-5}	3.4×10^{-3}	9.2×10^{-5}	Medium

Table 10.3-2 (Continued)

Incident	Release to Atmosphere (μCi)	First-Year Dose, mrem		Fifty-Year Dose Commitment, mrem		Expected Frequency of Occurrence[b]
		Bone	Lung	Bone	Lung	
Explosion of Hydrogen During Electropolishing	7.1×10^{-3}	5.9×10^{-6}	5.5×10^{-6}	2.1×10^{-4}	5.9×10^{-6}	High
Man Intrusion	(c)	3.5×10^{6}	2.1×10^{8}	7.0×10^{8}	5.2×10^{8}	Low

(a) This table is a summary of Table 11.2-3 in reference 1. It presents the highest dose from each of the decommissioning alternatives.

(b) Frequency of Occurrences: High $>1.0 \times 10^{-2}$ to 1.0^{-5}; Low $<1.0 \times 10^{-5}$ per year.

(c) This accident is for the ENTOMB alternative only and is postulated to be a deliberate but ignorant intrusion by man into the facility after knowledge of the facility is lost after a period of several hundred years. The case postulated assumes a 40-hour exposure to an average air concentration of 290 $\mu Ci/m^3$ of mixed oxides containing plutonium.

the failure of a HEPA filter which, as stated above, would result in a major accidental release, the public would be partially protected by the other filters in the system.

Radioactive waste materials are packaged and shipped offsite for burial during decommissioning of the reference MOX facility. These wastes include transuranic (TRU) contaminated wastes[(a)] that are shipped to a federal repository (deep geologic disposal) assumed to be located at 2,400 km (1,500 mi) from the plant site, and non-TRU wastes[(b)] that are shipped to a commercial shallow-land burial facility located about 800 km (500 mi) from the site. All wastes are assumed to be shipped by truck. To minimize the risk that radioactive shipments pose to the public and to transportation workers, federal and state regulations prescribe the containers, contents, packaging and handling, and burial requirements. The dominant radiation exposure pathway to transport workers and the public during transportation of radioactive wastes is external exposure for reasons similar to those discussed for PWRs in Section 4.3 1. The external dose for routine transportation operations for all truck shipments, both high and low-level wastes, from DECON is conservatively estimated to be about 6.4 man-rem to transport workers and 1.5 man-rem to the general public. For SAFSTOR (custodial) the radiation dose is estimated to be 8 man-rem to handling and transportation workers and 1.9 man-rem to the public. These doses are based on regulations of the Department of Transportation governing radiation levels in shipments of radioactive materials and on estimates the distances of travel and lengths of time of exposure that workers and the public might expect These doses are summarized in Table 10.3-1.

The severity of accidents that may occur during transportation of radioactive waste depends on a number of factors, such as speed, kind of accident, and accident locations. Regardless of the decommissioning alternative, the same total amount of radioactive material will be transported. Thus, the possible release of radioactivity will be dependent on frequency and kind of accidents, as shown in Table 10.3-3.

10.3.4.2 Decommissioning Costs

This discussion of the decommissioning costs is based on information in NUREG/CR-0129.[1] Table 10.3-4 summarizes the estimated costs in 1986 dollars for the decommissioning alternatives analyzed in this report. All cost estimates include an added 25% for contingencies.

For DECON, the decommissioning costs are estimated to be $13.9 million. For custodial SAFSTOR the total decommissioning cost is estimated to be $27.6 million and $47.3 million for 10-year SAFSTOR and 30-year SAFSTOR, respectively. These SAFSTOR costs include $5.8 million for preparation for safe storage, $0.98 million per year for continuing care, and $13.0 million for costs of deferred decontamination. A present value analysis of decommissioning costs indicates a disincentive to defer decontamination for the reference case indicated, primarily because of the high cost of continuing care relative to DECON costs and

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(a) TRU wastes are assumed to be those contaminated with alpha radioactivity from transuranic materials at a level of 10 or more nCi/g of waste.

(b) Non-TRU wastes are assumed to have transuranic alpha radioactivity of less than 10 nCi/g of waste.

Table 10.3.3 Estimated frequencies, radioactivity releases and doses for selected truck transport accidents

Severity of Accident (in Closed Van)	Frequency of Accident per Facility: DECON	Frequency of Accident per Facility: SAFSTOR	Release of Radioactivity[b] Ci	Radiation Dose for Maximum Exposed Individual (rem): 1st Year Bone	1st Year Lung	50 Year Dose Commitment Bone	50 Year Dose Commitment Lung
Minor	7.4×10^{-2}	9.9×10^{-2}	No Release	-	-	-	-
Moderate	1.8×10^{-2}	2.4×10^{-2}	1×10^{-4}	6.8×10^{-3}	2.6×10^{-2}	2.4×10^{-1}	6.5×10^{-2}
Severe	4.7×10^{-4}	6.3×10^{-4}	1×10^{-2}	6.8×10^{-1}	2.6	2.4	6.5

[a] Table adapted from NUREG/CR-0129, Table 11.4.3.

[b] Assumes a shipping inventory of 100 Ci of dispersable radioactive material.

Table 10.3-4 Summary of estimated costs for decommissioning the reference small MOX fuel fabrication plant

Item	DECON	SAFSTOR (Custodial) 10 years	SAFSTOR (Custodial) 30 years	ENTOMB
	Estimated Costs in Million of 1986 Dollars			
Initial Decommissioning[a]	13.9	5.8	5.8	4.3
Continuing Care	NA	8.8	28.5	NA
Deferred Decontamination[a]	NA	13.0	13.0	NA
Onsite Burial	NA	NA	NA	0.6
Total Costs (Rounded)	13.9	27.6	47.3	4.9

[a] Costs are based on ten shifts/week for most of the decommissioning. Decommissioning on a 24-hour/day basis would reduce costs and time requirements.

the high cost of deferred decontamination due to the long half-lives of the radionuclides involved. For ENTOMB, the decommissioning costs are estimated to be $4.9 million.

Labor costs are about 60% of the total costs for the DECON and SAFSTOR alternatives and about 50% for ENTOMB. Thus, there is considerable incentive to institute plans or techniques that could reduce labor, such as working around the clock for the total decommissioning activities to reduce support labor and license and miscellaneous costs. The deferral of decontamination requires additional costs to refurbish auxiliary facilities, to reinstitute a trained decommissioning organization, and to provide a new safety analysis and application for amended license.

Costs of management of the wastes from decontamination range from about 7% to about 20% of the total costs of decommissioning, depending on the decommissioning alternative. Thus, there is a modest economic incentive to reduce these costs. A potentially major economic factor favoring DECON is the value of the land or facility when released for productive uses. A facility in safe storage will provide economic return only as a tax write-off during the years before deferred decontamination, while a facility and land that have unrestricted use can be put to productive uses.

With the exceptions of the possible use of the process building and economic considerations, there is little or no advantage to either decommissioning alternative over the other regarding short-term and long-term uses. Once the facility has been prepared for custodial safe storage, the only area of concern for exposure to radionuclides is inside the exclusion area and, depending on the perceived potential accident risks, the rest of the property may be released for unrestricted use. In the reference facility and site, the building is sited in an exclusion area of 1.2 hectares (3 acres). This exclusion area represents about 0.25% of the total site area of 470 hectares (1160 acres).

However, in view of the fact that SAFSTOR offers no advantages from reduced radioactivity (in fact, a small increase in potential hazard from a buildup of ^{241}Am), it appears that DECON would be the more acceptable of these two decommissioning alternatives for MOX plants.

10.4 Environmental Consequences

The decommissioning of a MOX plant has few negative environmental consequences. As was defined in Section 2.3, the decommissioning of any nuclear facility involves the removal of radioactive material to levels which permit release of the facility for unrestricted use. The decommissioning alternative to be chosen depends to a large extent on the radiation dose, cost evaluations, desired future use of the site, desirability of terminating the license and the time period. The summaries of radiation safety and decommissioning costs are given in Section 10.3.4.

Demolition of remaining buildings (assuming prior decontamination to a level permitting unrestricted use of the MOX plant) is an optional owner and/or local government choice. Its major environmental impact on the surrounding population will be the resulting increase in noise level within the immediate vicinity of the plant (about 1 mile), primarily because of the use of explosives. However, most of the noise will be generated within the process building and will be muffled by the building until the final removal of the building shell.

10.4.1 Waste

A major environmental consequence of decommissioning is the commitment of land area to the disposal of radioactive waste. PNL made the estimates shown in Table 10.4-1 of the waste disposal volume required to accommodate radioactive waste and rubble removed from the facility and transported to a licensed site for disposal. The volume for ENTOMB does not include the volume of the entombing structure or the wastes entombed within it. The entombing structure is effectively a new shallow high level radioactive waste burial ground, separate and distinct from the ones in which the wastes in Table 10.4-1 are buried.

Table 10.4-1 Burial volume of radioactive waste and rubble resulting from decommissioning a reference MOX plant(m^3)

Disposition of Waste	DECON	SAFSTOR (Custodial) 10 Years	SAFSTOR (Custodial) 30 Years	ENTOMB
Deep Geologic Disposal	164	205[a]	205[a]	21
Shallow Land Burial	267	267	267	5
Total	431	472	472	26[b]

[a] Includes 52 m^3 of waste from preparation for safe storage.

[b] Does not include volume of entombing structure or entombed waste.

If shallow land burial of radioactive waste in standard trenches is assumed, then a burial volume of 267 m^3 of radioactive waste can be accommodated in less than 0.02 acres. An additional 164 m^3 would be required in a high-level waste repository for DECON. An additional 52 m^3 of high-level waste disposal space would be required for SAFSTOR.

These land use requirements for waste disposal are not large in comparison with the approximately 1160 acres used as the site of the reference MOX plant which could now be returned to unrestricted use

An additional effect of decommissioning is that the decontamination of a MOX plant will require the use of expendable tools and material that will be discarded as low-level waste.

10.4.2 Nonradiological Safety

Two potential nonradiological safety considerations are recognized. These are releases of chemicals used to decontaminate the plant and accidents in transporting materials to and from the plant.

Chemicals used in decontamination are detergents, oxidizing agents (acids), reducing agents, chelating agents, acids, caustics, and electropolishing solutions. Fumes from these chemicals will not be a safety hazard to workers provided there are adequate precautions and ventilation. Possibly the greatest potential for gaseous emissions is from the electropolishing process. Hydrogen and oxygen will be evolved in amounts that are proportional to the applied current and the surface area. For example, if a current of 10,000 A is applied to an area of 6 m^2 at an electropolishing station, hydrogen gas will be evolved at the rate of 4.5 m^3 per minute and oxygen at half that rate, for a total of 6.8 m^3 per minute. At this rate of release, these gases will entrain 10 mg of liquid electrolyte per m^3 of gas. The air filtering system operating for the removal of radionuclides will also remove this entrained liquid. Adequate ventilation will keep a fire or explosion from developing by preventing the hydrogen concentration in the air from building up to exceed the lower flammability level of 4.1%. This consideration will be very important when electropolishing a closed container such as a tank.[1]

Shipment of materials in and out of the plant will inherently have the same risk of accidents as any other shipping activities. Since transport is assumed to be by truck, the probability of accidents can be estimated from highway travel statistics. Assuming 630 round trips of 1600 km (1000 miles) to a shallow land burial site and 32 round trips of 4800 km (3000 miles) to a deep geologic burial site, there may be expected about 0.61 injuries and 0.036 fatalities per facility.[1]

10.4.3 Socioeconomic Effects

An immediately felt non-decommissioning effect of closing a MOX plant will be the loss of employment. A plant that has not been operating (as is the case with some of the existing plants) will require that a number of people be hired and trained, thus providing short-term employment (1 to 5 years). If decommissioning follows immediately after shutdown, some of the operating personnel will be used in the decommissioning work, thus providing a reduced level of employment for a short time. In the case of DECON, the staff size will remain at about a constant level until the decontamination activities near completion nearly 3 years after shutdown. On the case of custodial SAFSTOR, the staff will decrease as soon as initial chemical decontamination is completed. Throughout the period of continuing care, only maintenance, monitoring, and security personnel will be required. At the end of the continuing care period, the staff size will again increase to accomplish the final decontamination. Unless decontamination is performed by a contractor with a trained staff, a decontamination crew will have to be recruited and trained before this work begins. Changes in employment levels will not occur suddenly but will happen over the decommissioning period regardless of the decommissioning alternative. The custodial SAFSTOR alternative will require a small staff throughout the continuing care period, but this will be a small part of any local economy.

One possible benefit to the community will result from the removal of restrictions on the use of the land, which may happen if the facility is not used for other nuclear activities.

10.4.4 Noise and Aesthetics

One environmental effect will result from noise. Noise levels during decontamination will increase over operation levels because of the physical removal of concrete surfaces. Because these activities will be inside the buildings and because the buildings are some distance from the site boundary, these noises will not likely be heard offsite.

Aesthetic effects will not likely be a result of the decommissioning process per se, but will rather depend on the final disposition of the building and site. Removal of the MOX building will allow the site to be returned to its preconstruction state or be used for any other purpose. A building that is being held in continuing care may not require limitations on the use of the remainder of the site. The ENTOMB alternative will result in a large mound of earth whose blending into its surroundings will depend largely on the local terrain. This mound could be quite conspicuous in a flat area. In addition, the earthen fill must be taken from some borrow area and careful planning will be required to prevent this from creating another set of aesthetic problems. Thus, the aesthetic impact of ENTOMB is potentially greater than that for one of the other decontamination alternatives.

10.5 Comparison of Decommissioning Alternatives

The decommissioning alternatives as discussed here apply to a small MOX plant. Economics and radiation exposures may change somewhat for a facility with different characteristics.

The alternatives considered viable are DECON and custodial SAFSTOR. The differences between these alternatives are very small in matters of environment, ecology, and aesthetics. The major differences occur in occupational radiation exposure and decommissioning costs. Due to the long-lived nature of the radionuclides present in the MOX plant, doses and costs are not reduced even when decontamination is deferred for 30 years, as can be seen from Tables 10.3-1 and 10.3-4. Since the cost and doses of continuing care are major items and continue to increase with increasing safe storage time, the doses and costs associated with the complete SAFSTOR process exceed those for DECON. Thus, DECON would seem to be the most advantageous alternative.

Over the short-term, ENTOMB appears to offer some economic advantage in that initial costs are lower than for other alternatives. This advantage disappears, however, over the long-term because of the need to maintain surveillance of the site in perpetuity. Major societal concerns of this alternative include the problems associated with increased numbers of nuclear waste sites, holding long-lived hazardous materials near man's environment, and maintaining financial responsibility. All of these concerns combine to make ENTOMB an unacceptable alternative.

REFERENCE*

1. C. E. Jenkins, E. S. Murphy and K. J. Schneider, Technology, Safety, and Costs of Decommissioning a Reference Small Mixed Oxide Fuel Fabrication Plant, NUREG/CR-0129, Vols. 1 and 2. Prepared by Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission. February 1979.

*See footnote to reference in Chapter 1 for document purchasing availability.

11 URANIUM HEXAFLUORIDE CONVERSION PLANT

The function of a uranium hexafluoride (UF_6) conversion plant is to convert uranium concentrates, received from various uranium mills. to the purified uranium hexafluoride that is used as the feed material for the gaseous diffusion enrichment of ^{235}U. Currently there are five conversion plants in operation in the United States. Their names and locations are:

Allied Chemical	Metropolis, Illinois
Kerr-McGee	Sequoyah County, Oklahoma
Fernald DOE	Cincinnati, Ohio
Paducah, DOE	Paducah, Kentucky
Portsmouth, DOE[a]	Portsmouth, Ohio

Three other plants have been shut down: the Mallinckrodt Chemical Company Plant at Welden Springs, Missouri, the NUMEC Plant at Apollo, Pennsylvania, and the Oak Ridge Enrichment Plant.

The plant described here is a reference plant that is assumed to have processed 10,000 metric tons (MT) per year of natural uranium and to have been in operation for about 30 years. A detailed report on the decommissioning of a UF_6 plant, similar to those prepared for other facilities discussed in this EIS was issued in October 1981 (Ref. 1). The reference plant discussed here is based on the latest technology. For the plants listed above, currently operating plant processes vary from the reference plant in the type of equipment that is being used to perform the same process steps. However, from a decommissioning standpoint, the differences in the amount and size of equipment for various plant processes and the reference plant are small. Therefore, this decommissioning description is considered representative.

11.1 Uranium Hexafluoride Conversion Plant Description

11.1.1 Plant and Process Description

The reference UF_6 plant is assumed to occupy about 30.4 hectares (75 acres) within the generic site described in Section 3. The plant consists of three buildings containing approximately 120,000 ft^2 of floor area. The buildings are of normal industrial construction, with heavy concrete floors to support equipment. In addition, there are a series of retention ponds for sanitary waste and process raffinates. The plant is designed to receive U_3O_6 or yellowcake in 208-liter (55-gallon) drums from various uranium mills located in the western United States and to convert the feed stock to uranium hexafluoride (UF_6). Two processes, which differ only in the method of purification, are in use today. The major steps in either process are:

(a)The large hexafluoride conversion plant was put into safe storage in the 1961-62 period. It has since been converted to another use. There is currently a small hexafluoride plant for converting returned and reclaimed uranium compounds to feed for the cascade enrichment plant.

1. pre-process handling, weighing, sampling, and storage

2. conversion of the U_3O_8 or yellowcake to uranium trioxide (UO_3) by roasting

3. reduction of the UO_3 to UO_2 with hydrogen

4. hydrofluorination of the UO_2 to UF_4 with hydrogen fluoride

5. fluorination of the UF_4 to UF_6 with elemental fluorine

6. storage of the purified UF_6 in shipping cylinders

The purification step is added either at the beginning using a solvent extraction process or at the end by fractional distillation of the UF_6. The use of the solvent extraction purification step (the wet process) results in the radioactive uranium daughters (^{230}Th and ^{226}Ra) and impurities being left in the solvent extraction raffinate. The acidic raffinate is neutralized and the slurry is retained in lagoons. The dried slurry would be disposed of in a shallow-land burial ground or returned to a mill for uranium recovery and disposal with the tailings (see Figure 11.1-1). The dry process, on the other hand, removes the impurities from the UF_6 product stream by fractional distillation and incorporates them with other waste products for disposal as solid waste in a shallow-land burial ground (see Figure 11.1-2). All gaseous effluent streams are filtered, and those containing fluorine compounds are scrubbed with potassium or calcium hydroxide solution.

The plant equipment, fabricated mostly of monel, is mainly a series of fluidized bed chemical reactors with intermediate vessels, such as storage bins, air classifiers, product filters, cold traps. and air effluent purification systems. The plant facility has lagoon areas for neutralized liquid effluents and a burial area for disposal of defunct equipment.

The purified UF_6 is placed in cylinders for storage and future shipment to one of the Department of Energy's enrichment plants.

11.1.2 Estimates of Radioactivity Levels at UF_6 Plant Shutdown

The reference UF_6 plant processes 10,000 metric tons of natural uranium per year in the form of ore concentrate (yellowcake) produced by domestic uranium mills. The feed to the reference UF_6 plant is assumed to be a composite product of uranium, produced 85% from acid leach and 15% from alkaline leach, which has aged at least six months in sealed drums after milling. The radionuclides of primary concern are natural uranium, ^{226}Ra, ^{230}Th, ^{234}Th, ^{234m}Pa, and ^{222}Rn. The daughter products of radon are not listed as radionuclides of primary concern either because they have half-lives of less than 2 hours and do not accumulate in the bioenvironment (^{218}Po, ^{214}Pb, ^{214}Bi, and ^{210}Po) or because they individually contribute less than 0.02% of the total relative hazard (^{210}Pb, ^{210}Bi, and ^{210}Po). Analysis of the plant feed at the Allied Chemical Plant at Metropolis, Illinois[2], indicates that there are 2,800 picocuries of ^{230}Th and 200 picocuries of ^{226}Ra per gram of natural uranium. This amounts to 28 curies of ^{230}Th and 2 curies of ^{226}Ra entering the plant each year, the majority of which is recycled at the mills by wet processing or is sent to low-level waste burial as solid waste from dry processing. Natural uranium is the most abundant radionuclide present. The predominant health and safety consideration is not

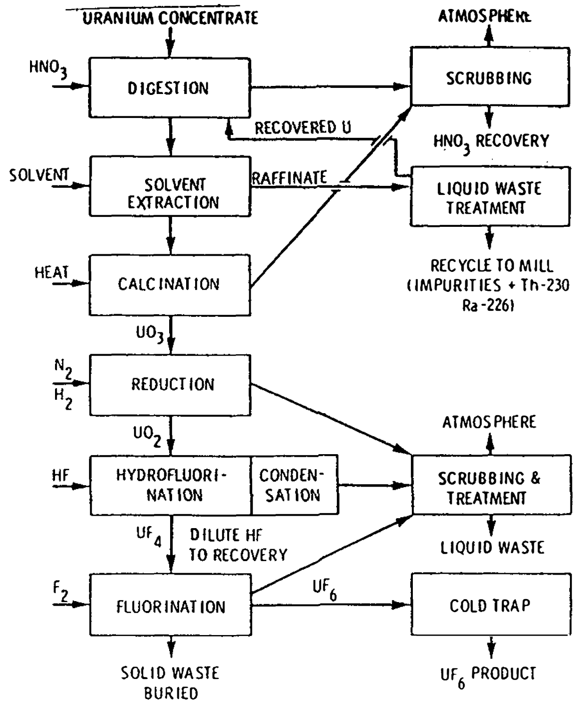

Figure 11.1-1 UF_6 production - wet solvent extraction fluorination process simplified block flow diagram

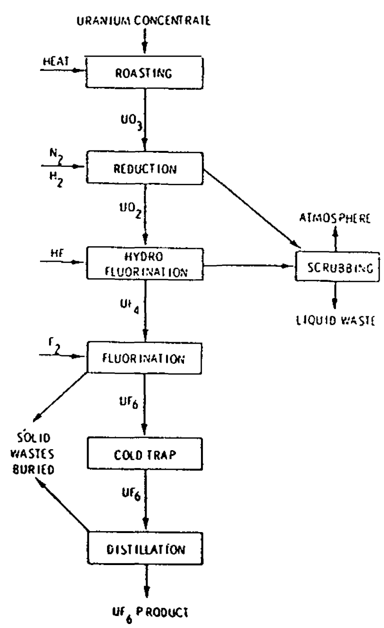

Figure 11.1-2 UF_6 production - dry hydrofluorination process simplified block flow diagram

radiological, but rather the effect that heavy metal (uranium) chemical toxicity has on the human kidney.

11.2 Uranium Hexafluoride Conversion Plant Decommissioning Experience

DOE has terminated UF_6 conversion at the Oak Ridge, Tennessee and Portsmouth, Ohio Enrichment Plants and at the Mallinckrodt Chemical Company Plant at Welden Springs, Missouri. The Welden Springs Plant is currently undergoing decommissioning, and the knowledge gained from this experience will be useful in the planning and decommissioning of similar plants The status of decommissioning of the Oak Ridge Plant is not known at this time

11.3 Decommissioning Alternatives

Once a UF_6 plant has reached the end of its useful operating life, it must be decommissioned. As discussed in Section 2.3, this means safely removing the facility from service and disposing of all radioactive materials in excess of levels which would permit unrestricted use of the facility. Several alternatives are considered here as to their potential for satisfying this general requirement for decommissioning. The decommissioning alternatives primarily considered and discussed here are DECON and SAFSTOR. ENTOMB is not considered a realistic alternative, and is included only for completeness.

The alternative used depends on such considerations as cost, dose, and the proposed use of the site. Special considerations involved in decommissioning the reference UF_6 plants include the following general assumptions:

1. natural uranium and its radioactive daughters are the only radioactive materials handled at the plant,

2. uranium spills that occur during the life of the plant, both inside and outside, are cleaned up immediately, and

3. safety reasons dictate that the maximum amount of uranium be removed from the plant prior to decommissioning.

Other considerations include the fact that decontamination of equipment is comparatively easy since most uranium found at the UF_6 conversion plant is quite soluble in nitric acid (HNO_3) and aluminum nitrate. The cleanout of the plant following shutdown removes essentially all of the uranium. Decommissioning following this cleanout should be equivalent to the cleanup of any chemical processing plant. An extensive radiation survey of the buildings and equipment would pinpoint any contaminated areas and thus allow an estimate to be made of the time and money needed for decommissioning. This radiation survey may show that all of the buildings and equipment can be released for unrestricted use, although it is more probable that some are releasable and some need further decontamination. Because of the low specific activity of uranium, radiation exposures of the public are negligible and therefore are of little concern, the owner could choose the most economical alternative for decommissioning with NRC concurrence. The most practical choice of decommissioning alternatives based on economics, appears to be basically only one: DECON. However, the other options listed above are briefly discussed here.

11.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use as early as 8 months after the end of facility operation.

DECON is advantageous because it allows for termination of the NRC license shortly after cessation of facility operations and removes a radioactive site. DECON is advantageous if the site is required for other purposes or if the site is extremely valuable. It is also advantageous in that the facility operating staff is available to assist with decommissioning and that continued surveillance is not required.

Because of the low radiation exposures from natural uranium, DECON could start at once following the final operational equipment cleanout and radiation survey. Salvageable equipment would be decontaminated as necessary by water or nitric acid flushing, hand scrubbing, or by vibratory or electropolishing techniques. Nonsalvageable or hard-to-decontaminate contaminated equipment would be shipped to a low-level waste burial ground for disposal. The structures used to house the UF_6 process would be decontaminated as necessary and then demolished or used for another purpose at the discretion of the owner. The site would be surveyed and any contamination would be removed. Most contaminated materials would be disposed of in a low-level waste burial ground.

The disassembly of the equipment would result in valves and piping being boxed for disposal. The larger vessels will be cut into pieces for disposal. The vessels could act as their own containers and have all openings bolted or welded closed. Trash would be stuffed into these vessels for disposal.

Ten percent of the concrete floor is assumed to be contaminated and 10 cm (4 in.) of the top of this surface is chipped away and disposed of as rubble. This estimate accounts for building materials that might need to be disposed of in a shallow-land burial site.

The removal of the uranium from the process equipment removes any significant radiation exposure to either the public or to the decommissioning worker. The radiation dose for the dismantling crew is expected to be less than for the initial cleaning. Average radiation dose rates in the plant during the initial cleaning are expected to be much less than 2 mrem/hr, which is the radiation dose rate from bulk quantities of uranium. Thus, the decontamination of the plant, packaging of contaminated wastes, and transporting of this material to a low-level waste burial ground is estimated to result in negligible radiation exposure to the public (see Table 11.5-1). An additional 17 man-rem is estimated for transportation of contaminated waste, including disposal of lagoon waste.

Table 11.5-1 summarizes the estimated costs in 1986 dollars for the decommissioning alternatives analyzed in this report. The DECON costs are estimated to be $12.1 million. These costs include costs for labor, equipment and materials, waste disposal and other expenses. Lagoon waste is assumed be disposed of at a uranium mill. If lagoon waste must be disposed of at a waste burial ground the cost is estimated to be $53 million. All cost estimates include an added 25% for contingencies. A time period of about 1 year is estimated for DECON.

Once DECON is complete, i.e., once the facility is decontaminated to levels permitting release of the facility for unrestricted use. the radioactive materials license would be terminated and the owner would be free to dispose of the site as he wished.

11.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a UF_6 plant in such condition that the risk to safety is within acceptable bounds, and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

Generally, the primary purpose of SAFSTOR for most nuclear facilities is that it results in reduced occupational exposure compared to DECON. However for the reasons given in Section 11.3 and as can be seen in Table 11.5-1 this is not the case for UF_6 plants. A disadvantage of SAFSTOR is that the licensee is required to maintain a material license and to meet its requirements at all times during safe storage. Other disadvantages are that SAFSTOR contributes to the number of sites dedicated to radioactive confinement, surveillance is required, the dollar costs may be higher than for DECON, and the experienced operating staff may not be available at the end of the safe storage period to assist in the deferred decontamination.

Safe storage preparation is the same as the initial decontamination. The buildings and areas would be secured, but because of the small amount of radiation (less than 1 mrem/hr) and minimal danger to an intruder, only periodic surveillance would be necessary (twice per week). The length of the continuing care period would then be at the option of the owner. Continuing care would cost approximately $125,000 per year. A safe storage period of 10 years would result in total SAFSTOR costs of $15.1 million, which is larger than for DECON. This would take place with no increase or decrease in total radiation dose to the public or workers. Deferred decontamination could take place at any time, would require the same steps as DECON and would result in similar costs and doses as for DECON.

For the reasons discussed in Section 11.3 radiation dose to the public would be negligible (see Table 11.5-1).

11.3.3 ENTOMB

ENTOMB of a UF_6 plant until its radioactivity has reached levels permitting release of the facility for unrestricted use requires its encasement in concrete to protect the public from radiation exposure. Because the radiation levels from the trace amount of natural uranium in the equipment and buildings are nearly zero and because the process buildings are not suitable for ENTOMB, this is a very expensive and unnecessary decommissioning alternative and is not considered a viable option.

11.3.4 Site Decommissioning

No site decommissioning other than a radiation survey is expected to be necessary since it is assumed that each spill will be cleaned up immediately. If failed equipment or other contaminated solids have been buried onsite, they will have to be removed to a low-level burial ground. However, the removal of onsite buried materials is expected to be a minor effort compared to the rest of the decommissioning

11.4 Environmental Consequences

The environmental consequences of decommissioning a UF_6 conversion plant are small. The largest environmental impact is postulated to be the use of about 0.2 hectare (0.5 acre) of irretrievable land for shallow-land burial and the consumption of materials (gasoline, wood, metal tools, etc.) during the decommissioning activities. Decommissioning would make the 30.4 hectares (75 acres) of plant-site land available for unrestricted use. Reactivation of the site as another industrial endeavor would be advantageous to the local residents, about 100 of whom worked at the plant. The occupational and public radiation doses which are negligible, are discussed in Section 11.3. Discussion of costs are also included in Section 11.3.

11.4.1 Waste Disposal

The volume of low-level waste to be disposed of is estimated on the basis that all process equipment is discarded. The volume estimated, 1,259 m^3, is considered to be a maximum that requires about 0.4 hectare (1 acre) of a shallow-land burial site. Any equipment that can be reused or released for salvage will reduce the volume sent to burial. The land used for burial is considered irretrievable. These land use requirements for waste disposal are not large in comparison with the approximately 1160 acres used as the site of the reference UF_6 plant which could now be returned to unrestricted use.

11.4.2 Additional Effects of Decommissioning

The socioeconomic impacts are mainly from the shutdown (not decommissioning) of the facility and associated loss of about 100 jobs. Since the main attributes of an industrial site are still available, it would be in the best interests of the local communities to establish a new industry that would supply jobs and money through taxes. On the basis of economics, this use of the site would probably be preferred to returning it to its original condition.

11.5 Comparison of Decommissioning Alternatives

Table 11.5-1 presents a summary of the decommissioning alternatives discussed in this section. The choice of an alternative generally depends on such considerations as dose, cost, and proposed use of the site. As discussed in Section 11.3 3, ENTOMB is not considered a viable option and is not listed in Table 11.5-1. Of the two remaining alternatives, DECON and SAFSTOR, DECON appears to be the more advantageous option. This is because the radiation doses are small for either alternative, while DECON has lower costs and results in release of the facility for unrestricted use in a fairly short time period.

Table 11.5-1 Summary of Decommissioning Alternatives

	DECON	SAFSTOR 10 Years	SAFSTOR 30 Years	SAFSTOR 100 Years
Total Cost (millions of constant 1986 dollars)[a]	12.1	15.1	17.6	26.4
Occupational Radiation Dose (man-rem)	62	63	65	67
Transportation Radiation Dose (man-rem)	17	17	17	17
Public Radiation Dose (man-rem)	5.7	5.7	5.7	5.7
Potential Industrial Accidents - Injuries	1.8	1.9	2.0	2.6
Fatalities	0.094	0.095	0.096	0.10
Manpower Expenditures (cumulative man-years)	43.4	60.3	80 9	150
Land Area Committed (acres)	0	75[b]	75[b]	75[b]

(a)Lagoon waste assumed to be shipped to a uranium mill. If disposal of lagoon waste at a commercial waste burial ground is necessary, add $53 million.

(b)Part of the site might be decontaminated, surveyed, and released for unrestricted use while the facility is put in safe storage, if desired.

REFERENCE*

1. H. K. Elder, Technology, Safety and Costs of Decommissioning a Reference Uranium Hexafluoride Conversion Plant, NUREG/CR-1757, Prepared by Pacific Laboratory for U.S. Nuclear Regulatory Commission, October 1981.

*See footnote to reference in Chapter 1 for document purchasing availability.

12 URANIUM FUEL FABRICATION PLANT

A uranium fuel fabrication plant (U-fab plant) is a facility in which enriched uranium, received as uranium hexafluoride (UF_6), is converted to UO_2 and formed into fuel pellets that are inserted into fuel rods. These fuel rods are, in turn, assembled into fuel bundles. There are two kinds of U-fab plants: high-level enriched U-fab plants which produce fuel for reactors that power naval vessels and for reactors that serve other special purposes, and low-level enriched U-fab plants which produce fuel for commercial nuclear power reactors that generate electricity. Plants that fabricate fuel for the U.S Navy are outside the scope of this EIS, but their decommissioning impact would be similar to the decommissioning of low-level enriched U-fab plants.

Some low-level enriched U-fab plants perform the whole operation, i.e., they receive UF_6 and produce fuel bundles. Other facilities operate in two stages, i.e., one plant receives UF_6 and produces UO_2 powder or pellets, and a second plant assembles the fuel rods and bundles. The reference plant for this study performs the whole operation.

This section presents an assessment of the environmental effects that may be expected from the decommissioning of such a facility. This section is based primarily on information from a study[1] of the decommissioning of a uranium fuel fabrication plant. In this study PNL selected the General Electric Plant located at Wilmington, North Carolina as the reference U-fab plant and assumed it to be located at the generic site. The generic site is described in Section 3.1. As part of this study, PNL developed information on the available technology, safety considerations, and probable costs for decommissioning the reference facility at the end of its operating life.

12.1 U-Fab Plant Description

The reference U-fab plant is assumed to have operated for 40 years, processing an average of 1000 MT of uranium per year. Production consists of three general kinds of activities: conversion of slightly enriched UF_6 to UO_2; mechanical production of fuel pellets and assembly of fuel rods and bundles; and recovery of uranium from scrap, wastes, and off-standard pellets.

Conversion of UF_6, as received from an enrichment facility, to UO_2 is accomplished by either a chemical or a direct process. In the chemical process, the UF_6 is first hydrolyzed to UO_2F_2 and ammonium hydroxide is added to precipitate the uranium as ammonium diuranate (ADU). Then the ADU is reduced and calcined to produce UO_2 powder. In the direct process, conversion reactors convert UF_6 directly to U_3O_8, which is then reduced to UO_2.

In the production of pellets, the UO_2 is pulverized and compacted to granules of a desired density. The granules are pressed into pellets which are sintered at high temperature in a reducing atmosphere. The pellets are then ground to proper size and loaded into zircaloy or stainless steel tubes which are dried, evacuated, filled with helium, and welded closed. The tubes (now called fuel rods) are tested for leaks, assembled into fuel bundles, inspected and stored for shipment.

The building is a two-story, windowless structure of concrete and steel. Interior walls, typically of concrete block, divide the building into discrete operations areas that house each of the production steps. When the plant is shut down and the final inventory cleanout has been performed, it is anticipated that there will be a total of about 270 kg of unrecovered uranium remaining in the plant. Of this amount, approximately 150 kg is in the equipment and 120 kg is in the ventilation system. This uranium has enrichments that range from 2% to less than 5% ^{235}U. CaF_2 is a waste product that is produced by treating the fluoride wastes with $Ca(OH)_2$. The CaF_2 is stored in waste ponds. Those CaF_2 waste ponds will contain some enriched uranium and will therefore require some decommissioning activity. Although CaF_2 has low solubility, the toxicity of inorganic fluorides in general suggests that these wastes may be a biological hazard.[2]

12.2 U-Fab Plant Decommissioning Experience

Several U-fab plants have ceased operation and are in various stages of decommissioning. At some facilities a high-level enriched U-fab operation has been shut down, leaving a low-level enriched U-fab operation still in production. Examples are a Babcock and Wilcox Plant at Apollo, Pennsylvania, and a Combustion Engineering Plant at Hematite, Missouri. At the Combustion Engineering Plant, there has been a partial cleanup, but at neither plant has the facility been completely decommissioned. Babcock and Wilcox also has a high-level enriched plant at Leechburg, Pennsylvania, that has been shut down and partially decommissioned. Some equipment has been removed but the ventilation system is still intact. United Nuclear closed a high-level enriched U-fab plant at New Haven, Connecticut, several years ago and U.S. Nuclear Corporation decommissioned a high-level enriched U-fab test and research facility at Oak Ridge, Tennessee.

Among the low-level enriched U-fab plants, two facilities which have been shut down are examples of decommissioning experience. A Kerr-McGee Plant at Crescent, Oklahoma, has been partly decommissioned. The plant is still intact, but the waste ponds have been cleaned up. This waste was loaded into drums and shipped to a burial ground.

Perhaps the best experience in decommissioning a low-level enriched U-fab plant was with a General Electric U-fab Plant in San Jose, California. At shutdown, the area was cleaned to administrative control levels not exceeding 1000 dpm/ 100 cm^2. Decommissioning was accomplished by dismantling and removing all of the process equipment and ventilation system and cleaning the building. Pipes, lighting fixtures, etc., were cleaned; fluorescent tubes were replaced; ceilings, walls, pipes, and lighting fixtures were damp-wiped, baseboard moldings and tile floors were removed, and concrete floors were vacuumed and mopped. Pump basins that had been formed by constructing concrete berms were cleaned up by removing the berms and wet grinding hot spots. The decommissioning effort was more extensive than should have normally been necessary, because on one occasion an accident occurred that released a large amount of UF_6 inside the plant. This accident contaminated not only all the building and fixture surfaces in the production areas but also the otherwise clean areas, such as offices.

12.3 Decommissioning Alternatives

Once a U-fab plant has reached the end of its useful operating life it must be decommissioned. As discussed in Section 2.3, this means safely removing the facility from service and disposing of all radioactive materials in excess of levels which would permit unrestricted use of the facility. Several alternatives are considered here as to their potential for satisfying this general requirement for decommissioning. The decommissioning alternatives considered and discussed here are DECON, SAFSTOR, and ENTOMB. The alternative used depends on such considerations as cost, dose, proposed use of the site and desirability of terminating the license.

Most of the residual radioactivity in a U-fab plant following shutdown is surface contamination,[3] although concrete in some areas of the plant may be contaminated to a shallow depth. It is assumed that a complete radiological survey of the plant and its equipment will be made as a normal operational procedure at the time of shutdown and that nitrate wastes have been removed and reprocessed as a part of normal operations. Thus, preparing the facility for unrestricted use will involve removal of the equipment, decontamination of the building, removal of some concrete surfaces as indicated by the survey, disposal of chemical wastes, and disposal of the CaF_2 wastes in the lagoons

Discussions of the decommissioning alternatives follow:

12.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use as early as the 9 months estimated for decommissioning after the end of facility operation.

DECON is advantageous because it allows for termination of the NRC license shortly after cessation of facility operations and removes a radioactive site. DECON is advantageous if the site is required for other purposes or if the site is extremely valuable. It is also advantageous in that the facility operating staff is available to assist with decommissioning and that continued surveillance is not required.

DECON of a U-fab plant presents few problems. The equipment and ventilation systems are removed and the building surfaces are damp-wiped. The equipment and vents most highly contaminated will be in the calciner, press, hammer mill, blender, and grinder areas. Some of this equipment and the furnaces can be reclaimed by replacing the parts that were exposed to the uranium. While the same may apply to the vent systems, it is likely that much of this material will be discarded. The replaced and discarded material will be shipped to a low-level waste burial ground. In some parts of the building, particularly the chemical processing areas, there will be places, such as pump basins, where it will be necessary to remove concrete floor surfaces. This will be accomplished by grinding, chipping or spalling. with the removed concrete being sent to a low-level waste burial ground.

The major problem in decommissioning a U-fab plant may be with the waste ponds and other areas where the soil is contaminated. Wastes in the nitrate ponds will have been removed, shipped to another plant, and reprocessed; but the calcium fluoride waste may have to be removed and shipped to a low-level waste burial ground. It is also possible that the CaF_2 waste may be removed and reprocessed at another plant to recover uranium. The CaF_2 would then be disposed of by the new owner. The nonradioactive chemical wastes will be sent to a chemical waste burial ground.

Analyses of radiation exposure and costs for DECON are presented in Section 12.3.4.

12.3.2 SAFSTOR (Custodial)

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a U-fab plant in such condition that the risk to safety is within acceptable bounds, and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

Generally, the primary purpose of SAFSTOR for most nuclear facilities is that it results in reduced occupational exposure compared to DECON. However for the reasons given in Section 12.3.4.1 and as can be seen in Table 12.3-1 this is not necessarily the case for U-fab plants. SAFSTOR could be advantageous in the event that there is a shortage of immediate waste burial accommodation. If this is the case it may be desirable to place the facility in custodial safe storage prior to deferred decontamination leading to release of the facility for unrestricted use. Custodial SAFSTOR for a U-fab plant would require only minimal cleanup with continuing maintenance and security. The CaF_2 wastes may have to be sold and removed for reprocessing or removed to a permanent waste burial ground. The chemical wastes will be removed to a chemical waste disposal area.

Another disadvantage of SAFSTOR, in addition to increased radiation exposure, is that the licensee is required to maintain a material license and to meet its requirements at all times during safe storage thus contributing to the number of sites dedicated to radioactive confinement for an extended time period. Other disadvantages are that surveillance is required, the dollar costs are higher than for DECON, and the experienced operating staff may not be available at the end of the safe storage period to assist in the deferred decontamination.

Over the short-term, custodial SAFSTOR might be temporarily expedient, but neither the cost of eventual decontamination nor the occupational radiation dose would be decreased by delaying decontamination due to the long half-lives of the radionuclides involved. It appears that the viability of this alternative will be determined on a case-by-case basis and will be dependent on the needs and resources of the UF_6 plant owner and the requirements of NRC.

Analyses of radiation exposures and costs for SAFSTOR are presented in Section 12.3.4.

12.3.3 ENTOMB

ENTOMB of a U-fab plant requires its encasement in concrete to protect the public from radiation exposure until its radioactivity has reached levels permitting release of the facility for unrestricted use. It is a possible but not very reasonable alternative. The building is not structurally suited to entombment, therefore, the initial entombing process would be costly. Because the radionuclides present in the UF_6 plant have very long half-lives, the structure would

Table 12.3-1 Summary of radiation safety analyses for routine decommissioning of the reference U-fab plant (man-rem)[a]

Occupational Exposure	DECON	SAFSTOR 10 years	SAFSTOR 30 years
Preparation	NA	0.4	0.4
Continuing Care	NA	6	18
Decontamination[b]	16	16	16
Transportation	2.6	2.6	2.6
Totals	18.6	25	37
(50-year dose commitment to the critical organ)			
Public Exposure			
Preparation	NA	0.06	0.06
Continuing Care	NA	0.05	0.15
Decontamination[b]	0.06	0.06	0.06
Transportation	0.53	0.53	0.53
Totals	0.6	0.7	0.8

[a] Adapted from Reference 1
[b] For SAFSTOR, this is deferred decontamination

have to be monitored and maintained in perpetuity, which is well beyond the time that required institutional control, could be expected to be effective (approximately 100 years is considered to be consistent with recommended EPA policy on institutional control for radioactivity confinement). Also. there would be no cost or safety advantage to ENTOMB, because DECON is simple, safe, and relatively inexpensive. In any event, the waste ponds would have to be removed and could not be entombed. ENTOMB is not a viable decommissioning alternative.

12.3.4 Summary of Radiation Safety and Decommissioning Costs

12.3.4.1 Radiation Safety

Residual radioactivity following inventory removal at a U-fab plant will be confined mainly to the interior parts of equipment and the ventilation system. The CaF_2 waste, containing some uranium, may have to be reprocessed or sent to a low-level waste burial ground.

The radioactivity in a U-fab plant is mostly due to ^{235}U and ^{234}U. External dose to decommissioning workers will be at plant background, which is about 1 mrem/hr. Because of the long half-life of ^{235}U, (approximately 7×10^8 years) this background will not be decreased appreciably by placing the plant in custodial safe storage for a time before deferred decontamination.

The approximately 270 kg of uranium that are still in the plant at shutdown contain about 8 kg of ^{235}U, which will be thinly dispersed over very large surface areas of the equipment and ventilation system. The possibility is remote that a worker at any particular location would contact a large concentration of ^{235}U. Nevertheless, some pieces of equipment will be more highly contaminated than others and the possibility exists that dust can be dislodged and suspended in the air where it will be inhaled. For this reason, appropriate protective clothing and face masks will likely be needed for decommissioning selected parts of the plant.

Occupational radiation exposure of workers performing the decommissioning activities results from external exposure for reasons similar to that discussed for PWRs in Section 4.3.1. Table 12.3-1 presents a summary of the radiation exposures that may result from each of the decommissioning alternatives. As can be seen from the table, the occupational exposures do not decrease as a result of using the SAFSTOR alternative. This is because of the long half-lives of the radionuclides present in the facility compared to the time the facility might be held in safe storage awaiting deferred decontamination. As can also be seen from Table 12.3-1, total estimated public exposures from decommissioning activities are very small. If the CaF_2 waste has not been removed and shipped to another plant for reprocessing, it may have to be packaged and shipped to a low-level waste burial ground for disposal. This would result in additional occupational and public radiation doses of 20 and 0.4 man-rem, respectively.

A range of possible accidents that would result in released radioactivity is postulated. The largest releases are from loss of HEPA filters. This would result in the same quantities of release and radiation doses and have the same probabilities of occurrence with either decontamination alternative.

A summary of the estimated doses to the public from accidents is shown in Table 12.3-2. Radiation doses to the public resulting from accidents are low enough to be considered insignificant.

Radioactive waste materials are packaged and shipped offsite for burial during decommissioning of the reference U-fab plant. The dominant radiation exposure pathway to transport workers and the public during transportation of radioactive wastes is external exposure for reasons similar to those discussed for PWRs in Section 4.3.1. The external dose for transportation is conservatively estimated to be 2.6 man-rem to transportation workers and 0.53 man-rem to the public for either DECON or SAFSTOR. These doses are based on regulations of the Department of Transportation governing radiation levels in shipments and on estimates of the distances of travel and lengths of time of exposure that workers and the public might expect. These doses are summarized in Table 12.3-1.

The severity of accidents that may occur during transportation of radioactive waste depends on a number of factors, such as speed, kind of accident, and accident locations. Regardless of the decommissioning alternative, the same total amount of radioactive material will be transported. Thus, the possible release of radioactivity will be dependent on frequency and kind of accidents, as shown in Table 12.3-3.

12.3.4.2 Decommissioning Costs

Table 12.3-4 summarizes the estimated costs in 1986 dollars for the decommissioning alternatives analyzed in this report. All cost estimates include an added 25% for contingencies. For DECON, the decommissioning costs are estimated to be $8.8 million. For custodial SAFSTOR, the total decommissioning cost is estimated to be $15.3 million and $24.7 million for 10-year and 30-year SAFSTOR, respectively. These SAFSTOR costs include $1.4 million for preparation for safe storage, $0.47 million per year for continuing care, and $9.3 million for deferred decontamination. A present value analysis of decommissioning costs indicates a disincentive to defer decontamination for the reference case indicated, primarily because of the high cost of continuing care relative to DECON costs and the high cost of deferred decontamination due to the long half-lives of the radionuclides involved. Therefore, from a cost standpoint, it is probably to an operator's advantage to choose the DECON alternative and convert the building to other uses.

Most of the cost of decommissioning a U-fab plant will be for labor. A large portion of the labor costs will be for handwashing the ceiling, wall, and floor surfaces of the building. Equipment that is still serviceable will also be damp-wiped or flushed with detergent solutions or weak acid where hand wiping is not possible. Some spalling of concrete floors may be required in areas such as pump basins which have had contact with uranium solutions. Deferring decontamination adds to the total cost because of the cost of labor for continuing care, of reactivating full utility service and of holding licenses. It does not decrease the cost of eventual decontamination.

Of the total costs listed in Table 12.3-4, the cost of waste management is $3.5 million. This includes $1.7 million for low-level waste burial of contaminated equipment, building components, and concrete, and $1.8 million for disposal of the chemical waste sludge (nonradioactive) in a chemical waste burial ground. The CaF_2 waste will potentially be disposed of in a low-level

Table 12.3-2 Summary of radiation doses to the maximum-exposed individual from accidental airborne radionuclide releases during decommissioning activities for either decommissioning alternative[a]

Incident	Release to Atmosphere (µCi)	First-Year dose, mrem		Fifty-year committed dose equivalent, mrem		Expected Frequency of Occurrence
		Bone	Lung	Bone	Lung	
Loss of Intermediate HEPA Filter After Duct Decontamination	2.7	2.3×10^{-3}	7.6×10^{-2}	4.5×10^{-3}	1.9×10^{-1}	High
Loss of Local Airborne Contamination Control, Loss of Vacuum Filter	0.70	6.0×10^{-4}	2.0×10^{-2}	1.1×10^{-3}	4.9×10^{-2}	High
Liquid Leak During Chemical Decontamination	4.5×10^{-3}	3.7×10^{-6}	1.3×10^{-4}	7.3×10^{-6}	3.1×10^{-4}	High

(a) Adapted from Reference 1

Table 12.3-3 Estimated frequencies and radioactivity releases for selected transportation accidents[d]

Accident Description	Accidents per Dismantlement	Release (Ci)[b,c]	Radiation Dose for maximum-Exposed Individual (rem)[a]: First-Year Dose, Bone	First-Year Dose, Lungs	Committed Dose Equivalent, Bone	Committed Dose Equivalent, Lungs
Minor Accident	2.3×10^{-2}	No Release	--	--	--	--
Moderate Accident	5.4×10^{-3}	1×10^{-7}	3.9×10^{-6}	1.3×10^{-4}	7.7×10^{-6}	3.2×10^{-4}
Severe Accident	1.4×10^{-4}	1×10^{-5}	3.9×10^{-4}	1.3×10^{-2}	7.6×10^{-4}	3.2×10^{-2}

(a) Maximum-exposed individual is assumed at 100 m from the site of the accident.

(b) Based on an inventory of 100 mCi, the expected maximum per truck shipment.

(c) Release fraction for respirable material for moderate and severe accidents are assumed to be 10^{-6} and 10^{-4}, respectively.

(d) Adapted from Reference 1.

Table 12.3-4 Summary of estimated costs for decommissioning the reference U-fab plant[a]

Item	Estimated Costs in Millions of 1986 Dollars DECON	SAFSTOR (Custodial) 10 year	30 year
Preparation	NA	1.4	1.4
Continuing Care	NA	4.6	14.0
Decontamination[b]	8.8	9.3	9.3
Total[c]	8.8	15.3	24.7

[a] Adapted from Reference 1.

[b] For SAFSTOR, this is deferred decontamination.

[c] Total does not include additional potential cost of contaminated CaF^2 disposal. This would add approximately 36.8 million to the total.

waste burial ground, and removal, packaging, shipment, and burial would cost an additional $36.8 million.

12.4 Environmental Consequences

Because radiological effects are quite small, the potential nonradiological effects will have the greater impact on the environment.

12.4.1 Nonradiological Safety

The area of greatest concern for the welfare of decommissioning workers is the calcium fluoride lagoons and storage pits. The very caustic nature of CaF_2 makes it necessary to protect the workers from contacting it on their skin and breathing the dust. The workers will therefore require protective clothing and respirators. The trucks used for transport to the burial ground will have the same risk of traffic accidents as with any other trucking operation, and the probability of accidents can be estimated from highway safety statistics. This probability is estimated to be 1.5×10^{-6} accidents per kilometer of travel.[4]

12.4.2 Commitment of Resources

The largest commitment of resources will be for space in chemical and low-level waste burial grounds. The burial volume of contaminated equipment, building components, and concrete is 1100 m^3, the burial volume of CaF_2 waste would be 29,600 m^3 (accounts for almost 3 acres of burial ground), and the burial volume of other chemical waste is 5300 m^3. Materials used up in decontaminating a U-fab plant will include cleaning supplies, such as detergents, clothes, mops, and brushes.

12.4.3 Socioeconomic Effects

In decommissioning a U-fab plant, many of the same people that operated the plant can do the cleaning, but the dismantling and moving of equipment will be done by electricians, plumbers, mechanics, and equipment operators, most of whom will be hired or contracted. The socioeconomic effects of decommissioning, then, will come from the employment of these craftsmen. The total decontamination crew may be larger than the operating crew, and so for the period of decontamination, the economic input to the community will increase. In the case of custodial safe storage, the work force may decrease to a security and maintenance crew for the period of continuing care.

Because of the planning time needed to precede the decommissioning, changes in the number of employees will not be sudden or without warning, and people will have time to find other employment.

12.5 Comparison of Decommissioning Alternatives

The options of DECON and SAFSTOR (custodial) both eventually end with the same results: a decontaminated facility that can be released for unrestricted use. The choice of an alternative generally depends on such considerations as dose, cost, proposed use of the site, and desirability of terminating the license. For a U-fab plant, due to the long lived nature of the radionuclides present, doses and costs are not reduced even when decontamination is deferred for 30 years, as can be seen from Tables 12.3-1 and 12.3-4. In addition since the cost and doses of continuing care is a major item and continues to increase with increasing safe storage time, the doses and cost associated with the complete SAFSTOR process exceed those for DECON Therefore, DECON appears to be a more advantageous option. For the reasons given in Section 12.3.3, ENTOMB is not considered a viable alternative.

REFERENCES*

1. Technology, Safety and Costs of Decommissioning a Reference Uranium Fuel Fabrication Plant, NUREG/CR-1266, Vols. 1 and 2, Prepared by Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, October 1980.

2. Sax, N. Irving, Dangerous Properties of Industrial Materials, Fifth Ed., Van Nostrand Reinhold Co., 1979.

3 Cleaning up the Remains of Nuclear Facilities - A Multibillion Dollar Problem, Report to the Congress by the Comptroller General of the United States, June 16, 1977.

4. Reactor Safety Studies - An Assessment of the Accident Risks in U.S. Commercial Nuclear Power Plants, WASH-1400 (NUREG-75/014), U.S. Nuclear Regulatory Commission, Washington, DC 1975.

*See footnote to reference in Chapter 1 for document purchasing availability.

13 INDEPENDENT SPENT FUEL STORAGE INSTALLATION

An independent spent fuel storage installation (ISFSI) is a facility for handling and storing irradiated spent fuel assemblies from nuclear power reactors until they can be permanently disposed of as high-level waste. The two basic design categories of ISFSIs are wet storage of the fuel and dry storage of the fuel. The design of the wet storage ISFSI is similar to that of reactor spent fuel storage pools except that the storage capacity is significantly greater. There are different designs for dry storage ISFSIs, however the four basic types that are considered here are drywell storage, silo storage, vault storage, and cask storage. For cooling the fuel, these dry, storage designs depend on such means as air currents, heat dissipation in the soil, and metal heat transfer fins.

This section presents an assessment of the environmental, financial, and socio-economic effects that may be expected from the decommissioning of an ISFSI. This section is based primarily on information from a study[1] of the decommissioning of five different reference ISFSIs corresponding to the five different designs noted above. In the study, each reference ISFSI design was assumed to be located at the generic site. The generic site is described in Section 3.1. As part of this study, PNL developed information on the available technology, safety considerations, and probable costs for decommissioning the five reference ISFSIs at the end of their useful operational lives.

13.1 Description of an Independent Spent Fuel Storage Installation (ISFSI)

13.1.1 Wet Storage ISFSI

In this design, spent nuclear fuel is stored under water in a large pool. The reference wet ISFSI is the installation at the General Electric Company's Morris, Illinois plant. The reference wet ISFSI has a capacity of 2000 metric tons of fuel. The facility is a below-ground, open-pool, four-section water basin for receiving and storing spent nuclear fuel.

The major structures of the reference wet ISFSI includes: (1) the main building which houses the cask receiving and decontamination areas, fuel unloading basin, control room, fuel storage facilities (i.e., the storage basins), basin support systems, and low-activity waste facility; (2) the ventilation filter building; (3) the plant stack, and (4) other minor support structures.

13.1.2 Dry Storage ISFSI

13.1.2.1 Reference Drywell ISFSI

In this design, spent nuclear fuel is stored dry in individual wells or caissons. The top of the well, located near ground elevation, is covered with a shielding plug. The drywell ISFSI uses the physical properties of soil to provide both a thermal sink and radiation shielding while the spent fuel is stored in underground drywells. The spent fuel is sealed in canisters that are placed in the drywells.

The reference drywell consists of three major components: (1) a hot cell facility for receiving, inspecting, and packaging spent fuel; (2) an onsite transporter; and (3) the fuel storage area which holds an appropriate number of underground drywells. The reference drywell ISFSI has a fuel storage area which is 16 hectares in area that will accommodate 4705 drywells holding 2000 MT or more of spent fuel as well as the other necessary components. The drywells within the fuel storage area are laid out on a grid that allows the necessary heat dissipation. The hot cell facility includes an area to receive spent fuel, an area to receive containers to be filled with spent fuel, an operating floor for packaging the fuel, a room for equipment maintenance, underground transfer tunnels, a control room, and a waste handling facility.

13.1.2.2. Reference Silo ISFSI

In this design, packaged spent fuel assemblies are stored in cylindrical, aboveground concrete silos. The silo ISFSI uses the massive thickness of the concrete silo for shielding and uses convective air currents for heat dissipation. Individually packaged spent fuel assemblies are placed in baskets in the silos.

The reference silo ISFSI consists of three major components: (1) a hot cell facility for receiving, inspecting, and packaging sent fuel; (2) an onsite transporter; and (3) a fuel storage area that holds an appropriate number of silos. The reference silo ISFSI has a fuel storage area which is 16 hectares in area that will accommodate 1120 silos holding 2000 MT of spent fuel as well as the other necessary components. The silos within the fuel storage area are laid out on a grid that allows the necessary heat dissipation. The hot cell is as described above in 13.1.2.1.

13.1.2.3 Reference Vault ISFSI

In this design, spent nuclear fuel is stored dry in arrays of tubes housed in massive concrete buildings of enclosed canyon structures. Convective or forced air flow provides cooling for the stored fuel.

The reference vault ISFSI consists of two major components: (1) a fuel storage area and (2) a hot cell. The fuel storage area is below-ground canyon-type construction, with encapsulated fuel and natural convective air circulation. It has a capacity of 2000 MT of spent fuel. The hot cell is as described above in 13.1.2.2.

13.1.2.4 Reference Cask ISFSI

In this design, spent nuclear fuel is stored in iron casks whose designs are similar to those commonly used for rail transportation of spent fuel in the U.S. The casks use thick iron-wall construction for shielding and use iron heat transfer fins for heat dissipation.

The reference cask ISFSI basically consists of a fuel storage area that contains a collection of specially shielded and sealed metal containers (casks) that are located in a security area on the generic site. The casks themselves serve as the storage medium. The reference facility has a capacity of approximately 2000 MT.

13.2 ISFSI Decommissioning Experience

At present, no ISFSIs have undergone decommissioning in the U.S. However, decommissioning information is available from facilities that have similar structural or design-use characteristics, such as reactors and nuclear fuel handling facilities since portions of their decommissionings are similar in nature to that anticipated for ISFSIs.

The PNL reports on decommissioning PWRs[2] and BWRs[3] contain information on the technology, safety and costs of the decommissioning of, among other things, the spent fuel pool and ancillary equipment located at the reactor. Many similarities exist between this facility and the reference wet ISFSI.

Data taken from the GE Morris Plant have indicated that Co-60 radionuclide levels in the storage pool have varied between 1×10^{-3} and 2×10^{-4} µci/ml and that radiation surveys of fuel baskets indicated doses of 50 mrem/hr or less.

There has been decommissioning experience at several hot cells which, as discussed above in 13.1, form part of certain of the dry reference ISFSIs. This experience includes hot cells and transfer tunnels at the Santa Susana Field Laboratory, the Hot Fuel Examination Facility hot cell at Idaho National Engineering Laboratory, and the hot cell facility at the Canyon Building at Oak Ridge National Laboratory. Activities at these facilities included decontamination and dismantling of the hot cell facilities.

13.3 Decommissioning Alternatives

Once an ISFSI has reached the end of its useful operating life it must be decommissioned. As discussed in Section 2.3, this means safely removing the facility from service and disposing of all radioactive materials in excess of levels which would permit unrestricted use of the facility. Several alternatives are considered here as to their potential for satisfying this general requirement for decommissioning. The decommissioning alternatives considered and discussed here are DECON, SAFSTOR, and ENTOMB. The alternative used depends on such considerations as cost, dose, physical design of the facility, types of residual radioactivity present, proposed use of the site, and desirability of terminating the license.

Discussion of the decommissioning alternatives follows:

13.3.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of a DECON procedure. The end result is the release of the site and any remaining structures for unrestricted use shortly after the end of facility operation. DECON is estimated to be completed in 13, 24, 10, 10, and 6.5 months for the reference wet, drywell, silo, vault, and cask ISFSIs respectively.

DECON is advantageous because it allows for termination of the NRC license shortly after cessation of facility operations and removes a radioactive site. DECON is advantageous if the site is required for other purposes or if the site is extremely valuable. It is also advantageous in that the facility operating staff is available to assist with decommissioning and that continued surveillance is not required.

To accomplish DECON, all potentially contaminated systems must be disassembled and removed and all contaminated material must be removed from the facility and be transported to a regulated disposal site. The simplicity of ISFSI design and the low levels of surface contamination anticipated to remain after operations are terminated make the DECON alternative advantageous. It appears that the decommissioning of an ISFSI can be done with a relatively small commitment of resources, thereby encouraging the selection of DECON as a decommissioning alternative.

Analyses of radiation exposure and costs for DECON are presented in Section 13.3.4.

13.3.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) an ISFSI in such condition that the risk to safety is within acceptable bounds, and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

SAFSTOR is normally considered to be an acceptable decommissioning alternative for facilities that contain short-lived radionuclides so that the residual radioactivity decays to acceptable levels for unrestricted release within a period of a few years. Even if unrestricted levels are not reached by decay alone, SAFSTOR might be acceptable for ISFSIs if the decay of short-lived radioactivity is followed by decontamination to remove the remaining long-lived radionuclides.

A disadvantage of SAFSTOR is that the licensee is required to maintain a material license and to meet its requirements at all times during safe storage thus contributing to the number of sites dedicated to radioactive confinement for an extended time period. Other disadvantages are that surveillance is required, the dollar costs are higher than for DECON, and the experienced operating staff may not be available at the end of the safe storage period to assist in the deferred decontamination.

Analyses of radiation exposures and costs for SAFSTOR are presented in Section 13.3.4.

13.3.3 ENTOMB

ENTOMB requires encasement of the ISFSI in concrete to protect the public from radiation exposure until the contained radioactivity has decayed to levels permitting release of the facility for unrestricted use. The relatively low levels of radioactive contamination anticipated to be present in retired ISFSIs, coupled with the physical designs of the facilities, makes ENTOMB an unlikely choice for decommissioning for most of the reference ISFSIs. The use of ENTOMB for a drywell or silo facility appears untenable. The construction of an above-ground entombment structure would not give the required assurance that radionuclide leakage would not occur. ENTOMB is generally considered a method for consolidating radioactive materials within a single structure that can be set aside until radioactive decay has reduced radionuclide levels to those acceptable for unrestricted use. The wide dispersion of individual drywells or silos around an ISFSI site makes such a decommissioning alternative not viable. Similarly, use of ENTOMB for a cask ISFSI does not appear viable.

From the standpoint of physical design, ENTOMB is a potential alternative when a concrete monolith is already utilized as part of the operational features of a facility. Entombment would be accomplished by sealing the entrances to the existing facility. However ENTOMB at a wet ISFSI would require either the expense of filling the pool completely with concrete or constructing a structurally sound thick concrete cap across the pool and hence would not appear to be a viable alternative.

Analysis of radiation exposures and cost for the case for which ENTOMB was examined in Reference 1 are presented in Section 13.3.4.

13.3.4 Summary of Radiation Safety and Decommissioning Costs

13.3.4.1 Radiation Safety

Estimates are made of the external occupational radiation doses that are accumulated by workers conducting decommissioning tasks. The dominant radioactive species contributing to occupational exposure during DECON is Co-60 and the dominant species after 10 years of SAFSTOR will be Cs-137. Occupational radiation exposure of workers performing the decommissioning activities results from external exposure for reasons similar to that discussed for PWRs in Section 4.3.1. Table 13.3-1 presents a summary of the radiation exposures that may result for the decommissioning alternatives considered in Reference 1. The dose resulting from ENTOMB at a vault ISFSI is estimated to be 45.5 man-rem, not including additional doses accumulated from surveillance and maintenance or potential delayed decontamination of the facility. The dose to the public from routine effluents during decommissioning activities for any of the reference ISFSIs is less than 1×10^{-5} man-rem for any of the decommissioning alternatives considered.

Table 13.3-1 Summary of occupational radiation safety analyses for routine decommissioning of the reference ISFSIs (man-rem)[a]

Type	DECON	SAFSTOR 10 Yr	SAFSTOR 30 Yr	SAFSTOR 50 Yr	SAFSTOR 100 Yr
Wet	53.4	35.1	28.0	27.6	27.6
Drywell	120.0	62.3	33.3	24.7	16.6
Silo	116.0	60.4	32.5	24.3	16.4
Vault	155.0	86.5	50.5	41.9	34.2
Cask	12.5	--	--	--	--

[a] Adapted from Reference 1.

Thus the estimated public exposures from decommissioning activities are very small.

Radioactive waste materials are packaged and shipped offsite for burial during decommissioning of the reference ISFSIs. The dominant radiation exposure pathway to transport workers and the public during transportation of radioactive wastes is external exposure for reasons similar to those discussed for PWRs in Section 4.3.1. The external dose for transportation is conservatively estimated to be less than 0.28, 0.073, an 0.14 man-rem to transport workers for DECON, SAFSTOR, and ENTOMB, respectively, for any of the reference ISFSIs, and less than 2.7×10^{-2}, 7.1×10^{-3}, and 1.4×10^{-2} man-rem to the public for DECON, SAFSTOR, and ENTOMB, respectively, for any of the reference ISFSIs. These doses are based on regulations of the Department of Transportation governing radiation levels in shipments and on estimates of distances of travel and lengths of time of exposures that workers and the public might expect.

13.3.4.2 Decommissioning Costs

Table 13.3-2 summarizes the estimated costs in 1986 dollars for the decommissioning alternatives analyzed. All cost estimates include 25% for contingencies. The cost of SAFSTOR for the wet ISFSI include $2.79 million for preparations, $93,700 per year for continuing care during safe storage, and the remainder of the cost during deferred decontamination. The cost of SAFSTOR for the drywell

Table 13.3-2 Summary of estimated costs for decommissioning the reference ISFSIs[a] ($Millions)

		SAFSTOR			
Type	DECON	10 Yr	30 Yr	50 Yr	100 Yr
Wet	7.18	9.63	9.69	10.34	14.62
Drywell	16.65	18.28	20.57	22.86	28.60
Silo	4.44	6.04	8.34	10.65	16.40
Vault	3.90	6.59	9.56	12.56	20.34
Cask	2.25	--	--	--	--

[a] Adapted from Reference 1. Values include a 25% contingency and are in constant 1986 dollars.

ISFSI includes $1.92 million for preparations and $114,650 per year for continuing care; for the silo ISFSI, the costs include $1.91 million for preparations and $115,100 per year for continuing care; and for the vault ISFSI the costs include $2.43 million for preparations and $156,125 per year for continuing care. All the costs include the costs of decommissioning all components associated with the ISFSI as described above in Section 13.1. For example, the costs for a wet ISFSI include costs for decommissioning the fuel storage area and associated equipment and structures, while costs for a drywell ISFSI include costs for decommissioning the fuel storage area, the hot cell, and the transporter. The cost for ENTOMB at the vault ISFSI is $2.8 million, plus a cost of $31,740 per year for annual surveillance and maintenance.

13.4 Environmental Consequences

13.4.1 Waste Disposal

The volume of low-level radioactive waste to be disposed of for DECON is estimated to be 2720, 6700, 920, 500, and 42 m^3 for the wet, drywell, silo, vault, and cask ISFSIs, respectively. The volume of waste for SAFSTOR at the drywell and silo ISFSIs is not expected to decrease below that for DECON because the dose rates for the contaminated drywells and silos do not decay to low enough values to permit release of these materials to unrestricted use and hence they must be disposed of in much the same manner as for DECON. Waste volumes at the wet and vault ISFSIs will decrease due to reduced quantities of radionuclides and corresponding waste quantities and for the wet ISFSI are estimated to be 1460, 620, and 350 m^3 for 30, 50 and 100 years respectively, and for the vault ISFSI are estimated to be 440, 400, and 390 m^3 for 30, 50, and 100 years, respectively. The waste volumes requiring burial would represent a use of less than one acre of land for the disposal. This amount is not large in comparison with the size of the ISFSI site (which is approximately 100 acres) which could now be returned to unrestricted use.

13.4.2 Socioeconomic Effects

The socioeconomic impacts are mainly from the shutdown (not decommissioning) of the storage facility, which would reduce the income of the community and region because of the loss of about 30 to 40 jobs.

In decommissioning an ISFSI, many of the same people that operated the plant can do the cleaning, but the dismantling and moving of equipment will be done by electricians, plumbers, mechanics, and equipment operators most of whom will be hired or contracted. The socioeconomic effect of decommissioning then, will come from the employment of these craftsmen. The total decontamination crew may be larger than the operating crew, and, if so, for the period of decontamination, the economic input to the community will increase. In the case of safe storage, the work force may decrease to a security and maintenance crew for the period of continuing care. Because of the planning time needed to precede the decommissioning, changes in the number of employees will not be sudden or without warning, and people will have time to find other employment.

13.5 Comparison of Decommissioning Alternatives

The decommissioning alternatives eventually end with the same results: a decontaminated facility that can be released for unrestricted use. The choice of an alternative generally depends on such considerations as dose, cost, the physical design of the facility, the desirability of terminating the license, and availability of waste disposal capacity. Based on the relatively simple design of the ISFSI, the low levels of surface contamination anticipated to remain after operations are terminated, and the fact that occupational doses at the reference ISFSIs are much less significant and much easier to manage than for power reactors, DECON appears to be a more advantageous option. DECON also costs less than the SAFSTOR options. SAFSTOR may be justifiable in some cases where there is a problem with off-site waste disposal since there is some reduction in occupational exposure for ISFSIs and reduction in waste disposal volumes for certain types of ISFSIs. ENTOMB is not expected to be viable for ISFSIs both because of the physical design of the ISFSIs and because of the long-lived radionuclides at the ISFSIs which would mean that there would have to be maintenance and surveillance at the facility well beyond the time that required institutional control could be expected to be effective (approximately 100 years is considered to be consistent with recommended EPA policy on institutional control for radioactivity confinement). Also, there does not appear to be a cost or safety advantage to ENTOMB, because when the costs of maintenance and surveillance are included the total cost of ENTOMB soon becomes larger than DECON and the occupational exposure is approximately the same as 30 or 50 year SAFSTOR. Hence ENTOMB is not expected to be viable for ISFSIs.

REFERENCES*

1. J. D. Ludwick and E. B. Moore, Technology, Safety and Costs of Decommissioning Reference Independent Spent Fuel Storage Installations, NUREG/CR-2210, Prepared by Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, January 1984.

2. R. I. Smith, G. J. Konzek, and W. E. Kennedy, Jr., Technology, Safety, and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130, Prepared by Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, June 1978.

3. H. D. Oak, et al., Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station, NUREG/CR-0672, Prepared by Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, June 1980.

*See footnote to reference in Chapter 1 for document purchasing availability.

14 NON-FUEL-CYCLE NUCLEAR FACILITIES

Non-fuel-cycle facilities are those facilities which handle byproduct, source and/or special nuclear materials but which are not involved in the production of power as outlined in Figure 2.1-1 of Section 2 of this EIS. These non-fuel-cycle facilities must be licensed by the NRC or the Agreement States.

There are thousands of non-fuel-cycle facilities in the United States at which byproduct, source, and special nuclear materials are handled under specific licenses of the NRC and the agreement states. These facilities house operations that vary from the occasional use of a few short-lived radionuclides by a doctor to the large scale processing of radioactive materials (gaseous, liquid, and particulate forms). The operations include a wide range of applications in industry, medicine, and research such as manufacture of smoke detectors, radiation therapy equipment, and manufacturing quality control instruments.

Tables 14.0-1 and 14.0-2 give the number of NRC specific material licenses and of agreement state licenses, respectively as of June 1978. Approximate numbers of those which are not connected with the fuel cycle are given in parentheses in Table 14.0-1. These numbers do not exactly represent the number of existing facilities since some of the commercial establishments are licensed under more than one part of the regulations and thus have more than one license.

A large majority of the non-fuel-cycle material licensees have facilities which do not require a major decommissioning effort. However, a few of the non-fuel-cycle facilities will require significant decommissioning procedures which may present some unique problems and which may have rather large decommissioning costs and significant environmental impacts. A detailed technical report on the decommissioning of non-fuel-cycle nuclear facilities[1] has been prepared and published in February 1981 by Battelle Pacific Northwest Laboratories and is the basis for the information in this section. The emphasis in that report, and in this EIS, is on some selected facilities which are considered to involve significant decommissioning activities. Examples of these facilities are: manufacturers of sealed sources, manufacturers of radiochemicals, research and development institutions, and processors of ores in which the tailings contain licensable quantities of radionuclides. Costs and radiological impacts of decommissioning have been estimated for individual reference facilities such as laboratories for the manufacture of labeled compounds. One licensee's facilities may include a number of such individual facilities. Decommissioning of reference site components has also been studied.

14.1 Facilities Descriptions

14.1.1 Selected Types of Materials Facilities

Brief descriptions of selected types of non-fuel-cycle nuclear facilities are given in the following subsections. Reference individual facilities and sites have been selected which are representative of facilities for these types of operations in order to facilitate estimates of costs and radiation doses due

Table 14.0-1 NRC Material Licenses as of June 1978

Byproduct			
Medical	2,239		
Academic	384		
Industrial	4,205		
Civil Defense	104		
Other	27		
Total Byproduct		6,959	(6,924)[a]
Source		400	(332)
Special Nuclear		720	(583)
Total		8,079	(7,839)

[a] Licenses not connected with the nuclear fuel cycle are in parenthesis. These numbers were obtained by subtracting fuel cycle facilities and also export/import licenses which are, in effect, paper transactions and do not represent separate facilities.

Table 14.0-2 Agreement State Licenses (June 1978)

Medical	4,749
Academic	867
Industrial	5,030
Civil Defense	185
Other	900
Total	11,731

to decommissioning. Descriptions of these individual reference facilities and sites are given in 14.1.2.

14.1.1.1 Sealed Source Manufacturer

Sealed sources are manufactured for such uses as reference standards, moisture probes, quality control instruments, therapy units, and smoke detectors. In general, these uses require long-lived isotopes, but fairly weak sources, except for ^{60}Co therapy units in which high-energy, high-intensity gamma ray emission is the most important consideration. The manufacturing process is a hand operation that does not lend itself to mass production. Alpha and beta emitters are plated on platinum, stainless steel, or aluminized mylar film and mounted in aluminum rings to form standard disc sources. Liquid gamma sources are sealed in plastic or glass vials, and solid gamma sources are mounted in rods or plastic discs.[2] The materials are handled in hoods, glove boxes, or hot cells, depending on the kind and energy of emissions (exposure potential of the isotope).

Contaminated glassware and equipment that cannot be economically reclaimed are discarded into drums for shipment to a waste burial ground. Spills are cleaned up when they occur, and the area and equipment are monitored regularly.

Ventilation systems utilize absolute filters, and contamination is thus generally confined to the interiors of the hoods, glove boxes or cells, and the ducts and filters.

The reference individual facilities in sealed source production are based on laboratories at New England Nuclear Corporation (NEN) of Boston, Massachusetts. NEN has manufacturing facilities at both Boston and Billerica, Massachusetts. These buildings contain a number of small laboratories, each of which is devoted to a specific process and/or isotope. Each laboratory contains one or more hoods, glove boxes, and/or hot cells. People entering the laboratory areas change shoes or put covers over their shoes; when exiting, they change again and monitor their hands and shoes for radioactivity. Radioactive wastes are placed in drums and stored in separate buildings until shipped to a waste burial ground or, in the case of short-lived isotopes like ^{32}P, the drums are held on the premises until the isotope has decayed to a suitable level of activity.

14.1.1.2 Radiochemical and Radiopharmaceutical Manufacturers

Manufacturing facilities for radioactively labeled chemicals and pharmaceuticals are much the same as those for the manufacture of sealed sources in that operations are carried out in ventilated enclosures. Chemical manufacturing, however, requires more extensive and complicated laboratory equipment to perform the inorganic reactions and organic syntheses. The isotopes are either shipped in from an outside supplier or are produced in onsite cyclotrons.

The basis for reference individual facilities for the manufacturing of labeled chemicals is also New England Nuclear Corp. Chemical syntheses are carried out at both their Boston and Billerica plants. The physical facilities for these operations are similar to those for sealed source manufacturing.

Syntheses are performed in small batches in hoods, glove boxes, or hot cells equipped with absolute filters. Each chemical is produced in a separate laboratory, which is a restricted area. As compounds progress through their synthesis, they are moved from hood to hood through connecting doors and are packaged in lead shipping containers before being removed from the hood. Radioactive solid waste, including glassware, is placed in plastic-lined drums for disposal. Before being removed from the restricted area, liquid wastes are put in leak-proof, shatterproof containers filled with absorbent materials and are labeled as to quantity, type of activity, date, and surface dose rate.

All wastes are placed in drums and moved to a separate building where the short-lived isotopes, such as ^{32}P, are allowed to decay to negligible levels. Wastes with long-lived isotopes are shipped to waste burial grounds.

14.1.1.3 Broad Research and Development (R&D) Program Facility

R&D facilities using nuclear materials cover an extremely broad range of activities. A large university is representative of many of these R&D activities. An example is the University of Washington in Seattle, Washington. There are about 400 laboratories or health treatment areas on the university campus that have used or are using radioisotopes. Radioisotopes are used in chemistry and physics laboratories to conduct basic experiments and in biological laboratories to investigate absorption and metabolic phenomena. These laboratories, in general, present no decommissioning problems because the isotopes used are short-lived and are of low activity. The university also uses radioisotopes for various medical purposes in a university hospital and a health services complex. These uses include both radiation exposure from sealed sources and injections of short-lived isotopes. Most of these isotopes are produced elsewhere, but ^{99}Tc is produced from ^{99}Mo in a technetium generator.

Probably the highest intensity source used is the sealed ^{60}Co source used in biological irradiation studies of fish. This source is on the order of 40,000 Ci, so shielding requirements are extensive, and these shielding requirements must be considered in decommissioning activities.

The longest lived isotopes normally used are ^{3}H and ^{14}C, both of which are low-energy beta-emitting isotopes. Other isotopes that are commonly used as tracers include ^{125}I, ^{55}Fe, ^{36}Cl, ^{26}Al, ^{55}Cr, and ^{35}S. Radioactive wastes are packaged for shipment to a waste burial ground.

A reference institutional laboratory has been studied. It was not taken directly from the University of Washington but is a small complex of rooms designed to represent the types of facilities typical of an R&D facility.

14.1.1.4 Ore Processors

Non-fuel-cycle processing facilities that deal with ores containing appreciable concentrations of radionuclides are licensed to store their mill tailings. There are relatively few such facilities in the U.S., but the volumes of tailings they generate are sufficient to require a significant decommissioning effort.

The reference rare-metals refinery is a plant that refines raw material for the recovery of the tantalum and niobium. The raw material is the slag produced by tin smelters located on the Malay Peninsula. This slag consists of glassy flakes or pellets that contain 0.1 to 0.5 wt % U_3O_8 and ThO_2. In one building the slag is ground, roasted, and digested with hydrofluoric acid.

The hydrofluoric acid is filtered off and passed to a facility for the chemical extraction of niobium and tantalum. The sludge, which contains essentially all of the thorium and uranium, is pumped to a settling pond located about 100 m from the refinery. In the settling pond, the water is allowed to evaporate, converting the sludge to a glassy solid.

At some facilities the settling pond is unlined. At newer facilities it is lined with a fluorocarbon-type material, and at one facility the tailings are dried and stored in above ground concrete buildings.

In such a facility, the radioactivity is primarily in the tailings, nowhere else in the operation is there significant radioactive contamination. Costs for decommissioning the remainder of the facility and site would be primarily that of the termination survey. The operational problem is that there is currently no satisfactory place to ship the tailings for disposal. Storage in specially made aboveground structures becomes expensive and cumbersome, and in addition, the operating license may limit the amount of tailings that can be stored onsite.

Since the main decommissioning task involves the disposition of the tailings pile or pond, a reference ore tailings pile has been studied.

14.1.2 Reference Facilities and Sites

14.1.2.1 Radioactive Material Processor Laboratories

Five example laboratories for the manufacture of sealed sources or radiochemicals were included in the PNL study,[1] each limited to the processing of one radioactive nuclide:

1. ^{3}H Laboratory - The reference laboratory for the manufacture of ^{3}H - labeled compounds is 120 m^2 in area and contains five fume hoods and six glove boxes, each separately vented through roughing and HEPA filters, 20 linear meters of laboratory workbenches, refrigerators, a freezer, and a storeroom.

2. ^{14}C Laboratory - The reference laboratory for the manufacture of ^{14}C - labeled compounds is 80 m^2 in area and has four fume hoods, four glove boxes, 15 linear meters of workbenches limited to nonradioactive operations, refrigerators, freezers, a storage room, a sink through which low levels of radioactivity are discharged to the sanitary sewer, and vacuum manifolds and distillation equipment typical of an organic chemistry laboratory.

3. ^{125}I Laboratory - The reference laboratory for the manufacture of ^{125}I - labeled compounds is 48 m^2 in area and has four fume hoods with a specially designed glove box located inside each hood. Each hood and glove box is equipped with an activated charcoal filter. In addition, there are 8 linear meters of workbenches, a refrigerator, storage cabinet, and a sink. Liquid effluent from this sink is discharged to a tank where it is held for decay, monitored, and diluted before discharge to the sanitary sewer; wastes from processing operations are not discharged to the sink, but are packaged and shipped to a commercial shallow land burial site for disposal.

4. ^{137}Cs Laboratory - The reference laboratory for the manufacture of ^{137}Cs sealed sources is 48 m^2 in area and has two small hot cells, two fume hoods, 4 linear meters of workbenches, locked storage casks, and a sink with holdup tank which is not used for discharge of wastes from processing.

5. ^{241}Am laboralory - The reference laboratory for the manufacture of ^{241}Am sealed sources is 60 m^2 in area and contains two fume hoods, seven glove boxes, 6 of these being connected in series by transfer tunnels, a storage cabinet for nonradioactive supplies, a small workbench, and a change area.

14.1.2.2 Institutional User Laboratory

The reference institutional user laboratory is representative of the type of facility a broad research and development licensee might have. It contains a room for synthesizing labeled compounds and for preparing radioactive samples, a small-animal laboratory, a counting room, office space, and an equipment and storage room. The radioisotope room is approximately 49 m^2 in area and contains a glove box, three fume hoods, two sinks, a lead storage unit, a refrigerator, and workbenches. The animal laboratory contains two fume hoods, a sink, animal cages, and workbenches.

14.1.2.3 Reference Sites

Three examples of contamination onsite were studied:

1. An underground drain line and holdup tank - 20 m^2 of 0.1-m - diameter cast iron pipe and 1.5-m diameter by 2 m^2 high cylindrical steel tank buried 1.5 m below the ground surface.

2. Contaminated ground surface - a 40,000 m^2 site with 1000 m^3 of soil contaminated with residue from uranium processing operations.

3. Rare metals refinery tailings pile - an unlined settling pond 100 m long by 50 m wide by 5 m deep with a 2½ to 1 slope on each side dug into a clayey silt on a 20,000 m^2 site.

14.2 Non-Fuel-Cycle Materials Facilities Decommissioning Experience

Decommissionings of non-fuel-cycle facilities have been many and varied, and a large number of these operations have had little cost or environmental impact. Because of their unique sizes, locations, and conditions, no two facilities had identical decommissioning problems or conditions. Documentation on these decommissionings is fragmentary. However, a number of things, as discussed below, are apparent from the documentation that is available on the decommissioning of these facilities.

First, a large variety of facilities, both commercial and others, have been successfully decommissioned without unreasonable occupational exposures or significant public exposures. The decommissioning approach has generally been to decontaminate the facility to radioactivity levels low enough to permit release of the facility for unrestricted use.

Each facility can present problems that are unique to its decommissioning. In some cases, these problems can lead to uncertainties in estimating costs for decommissioning, even at the time of shutdown. This is particularly true for a facility where a number of operations involving processing of a variety of nuclides have been carried out and an adequate history of operations and events has not been documented. However, what is also apparent is that the same basic approach to decommissioning applies to all facilities and that knowledge obtained from experience in decommissioning, in general, including some methods of facilitation can be applied as appropriate to any facility.

There has also been some decommissioning experience specifically relevant to the types of facilities chosen as references. Manufacturers of sealed sources and labeled chemicals carry out their operations in small batches in glove boxes, hoods, or remote operation cells, and contamination outside these structures is limited almost entirely to the ventilation ducts and filters. The isotopes creating the worst problems in these facilities are ^{14}C, which requires tedious inspection and cleanup, ^{3}H, which is easily dispersed and requires many washes to remove; and gases of ^{125}I, ^{131}I, and ^{85}Kr. Equipment for handling cesium and strontium becomes so thoroughly contaminated that it is normally sent to waste burial without any attempt to clean it up.

New England Nuclear Corp. has had a great deal of experience with these kinds of structures and has decommissioned an entire five-story building plus basement which had contained biochemical and organic chemical laboratories for the manufacture of compounds labelled with ^{3}H, ^{14}C, and ^{32}P, and is now being put to other, non-nuclear uses. Decommissioning criteria used by NEN are given in Ref. 3. This decommissioning consisted of removing all the isotope-handling equipment and ventilation ducts, decontaminating them when possible, and if not economically recoverable, disposing of them to low-level waste burial grounds. In practically all cases, it was not considered economically feasible to decontaminate ductwork. The entire facility was surveyed for radioactivity and any areas with contamination levels of 900 or more dpm per 100 cm^2 were cleaned to reduce contamination by at least a factor of 2. The walls and ceilings were steam cleaned. The floors consisted of vinyl tile laid over plywood on top of the original floor. Where contamination occurred, the floor tiles were replaced and, if necessary, sections of the plywood were cut out and replaced. Some of the worst areas of contamination were under the laboratory benches, which were not accessible for routine cleaning. Glove boxes that were not to be reclaimed were spray painted, loaded with contaminated equipment, filled with a quick-setting foam material, and shipped to a low-level waste burial ground. Lead bricks were etched with HCl, and areas contaminated with ^{14}C were washed with NaOH and NH_4OH. These same procedures are followed on a continuing basis as NEN rearranges and remodels other laboratories.

Experience with decommissioning of commercial non-fuel-cycle ore processing facilities is limited, primarily because there are few such facilities in the U.S. The ores handled in these facilities have such low levels of radioactivity that the machinery can be readily decontaminated and surveyed to confirm that radioactivity levels are low enough to allow unrestricted use. Therefore, the main problems with decommissioning are disposal of the slag or tailings and cleaning up of spills. Kawecki Berylco Industries, Inc. has one such site in which the contaminated surface soil was scraped into a single pile and stabilized with vegetation. The matter of final disposition of the sludge from current operations containing the unextracted uranium and thorium has not been resolved.

Also relevant to the decommissioning of this type of facility is the ongoing work to decontaminate some sites which had been used some time ago for similar processes and subsequently abandoned. Two of these are: Reed Keppler Park in West Chicago, where thorium-containing wastes from a rare earth processing plant had been deposited in the 1940s, and a plant in Parkersburg, West Virginia, where ore had been processed for the recovery of zirconium and hafnium.

Experience in dealing with uranium mill tailings piles is also relevant to decommissioning this type of operation since they present similar problems.

14.3 Decommissioning Alternatives

Decommissioning alternatives likely to be used for non-fuel-cycle materials facilities are discussed in the following subsections, first as they apply in general and then as applied specifically to the reference facilities. The general section describes each of the alternatives presented in Section 2.4 as they apply to non-fuel-cycle facilities. The specific section for each reference facility discusses only those alternatives considered viable for that facility.

14.3.1 Decommissioning Alternatives for Non-Fuel-Cycle Facilities

Once a non-fuel-cycle facility has reached the end of its useful operating life it must be decommissioned. As discussed in Section 2.3, this means safely removing the facility from service and disposing of all radioactive materials in excess of levels which would permit unrestricted use of the facility. Several alternatives are considered here as to their potential for satisfying this general requirement for decommissioning. The decommissioning alternatives considered and discussed here are DECON, SAFSTOR, and ENTOMB.

Since there is such a large range in the type and size of facilities and operations licensed to handle radioactive materials, the level of effort required to decommission these facilities varies greatly. The necessary actions can vary from essentially administrative procedures for small facilities (in addition to a final certification survey which could be similar to operational surveys) to a multi-million dollar effort for the more significantly contaminated facilities. For many materials handling facilities it may be quite straightforward to determine what actions are necessary; for some, however, detailed consideration of more than one viable alternative may be required. Any of the decommissioning alternatives listed above may be viable for some of the non-fuel-cycle facilities. For a large number of non-fuel-cycle facilities some variation or combination of these alternatives will be the best choice. Discussion of the decommissioning alternatives follow.

14.3.1.1 DECON

DECON is defined as the immediate removal and disposal of all radioactivity in excess of levels which would permit release of the facility for unrestricted use. Nonradioactive equipment and structures need not be torn down or removed as part of DECON procedures. The end result is the release of the site and any remaining structures for unrestricted use. A large number of non-fuel-cycle facilities will require some positive action in order to reduce radioactivity to levels considered acceptable for releasing the facility for unrestricted use. The procedures necessary for DECON vary greatly with the type of facility and its operation. Any procedure, whether involving only removal of sealed sources, decontamination, or dismantling, will follow the general concepts defined for DECON in Section 2.4.2. DECON can include dismantling, removing, and disposing of any contaminated equipment, as well as decontaminating or removing any contaminated parts of the building.

For many non-fuel-cycle facilities, the most appropriate decommissioning alternative will be DECON. This will involve decontamination of the facility; most licensees will not need to dismantle the facility.

In the case of an ore processing facility, removal of sludge also follows the general concept of DECON. An extension of this option is chemical extraction of the radionuclides, in which case the depleted sludge can be disposed of in a landfill and the radionuclides taken to a waste burial site or sold.

14.3.1.2 SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a non-fuel-cycle facility in such condition that the risk to safety is within acceptable bounds, and that the facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination).

For some of the materials facilities, SAFSTOR may be an acceptable and desirable decommissioning alternative. The simplest case illustrating the advantage of SAFSTOR would most likely be if most or all of the radioactivity in a specific facility is from relatively short-lived nuclides that will decay to levels permitting unrestricted use of the facility in a short time. In this case, little action, in some cases just a radiation survey, is expected to be required at the time of deferred decontamination. During the safe storage period, the facility would have to be made secure against intrusion. Limited surveillance and monitoring would also be required.

Stabilization may be a decommissioning alternative considered for the tailings pile remaining at ore processing facilities. At this time, the NRC has not determined whether this will be acceptable; but currently its acceptability would be considered on a case-by-case basis. Stabilization of tailings piles would be considered as preparation for safe storage and would require monitoring until final disposition.

14.3.1.3 ENTOMB

ENTOMB requires the encasement of a facility in concrete to protect the public from radiation exposure until its radioactivity has decayed to levels permitting unrestricted use of the facility. For a non-fuel-cycle facility, ENTOMB would require the construction of a heavily reinforced concrete building in advance of licensing in which the facility operations would be conducted. Given the expense of construction and the low radioactivity level of most of the isotopes to be handled, ENTOMB does not appear to be a viable alternative.

14.3.2 Decommissioning Alternatives for Sealed Source and Radiochemical Manufacturers

The same kinds of facilities are used in the manufacture of sealed sources and radio-labeled chemicals. Since the methods for decommissioning these facilities are the same, they are combined in this discussion. The alternatives considered for decommissioning these facilities are DECON and SAFSTOR. These are discussed below.

14.3.2.1 DECON

DECON is a logical alternative for facilities such as those of New England Nuclear Corp. which have been established for the manufacture of sealed sources and radio-labeled chemicals. It is relatively uncomplicated, will eliminate a need for continued monitoring, and will release the facility for other uses.

Decontamination activities will include the removal of hoods, glove boxes, hot cells, laboratory benches, and ventilation systems. Room surfaces will be washed and floor coverings removed as needed to eliminate hot spots that may have resulted from spills.

In planning a decommissioning action, it is important to know the history of the operation, how diligent the operators were in keeping the rules regarding contamination and releases, and how good a record of accidents and spills was kept.

Methods of disposal of equipment will depend on what isotopes are involved and on future use of the equipment. Hoods that have been used for strontium and cesium may be so badly contaminated that they cannot be reasonably and economically cleaned for further use. These will be shipped to low-level waste burial. Other hoods may be decontaminated to a suitable radioactivity level for reuse in a nuclear facility by removing the baffle and washing the hood surfaces, or, if they are easily decontaminated or have been used with short-lived isotopes, they may be cleaned and possibly made suitable for unrestricted use. It may be economically attractive to decontaminate stainless steel equipment by electropolishing.

Hoods that are to be discarded as low-level waste will be painted to seal in the radioactivity, filled with other contaminated equipment, such as ductwork and filter boxes, and packaged in plywood boxes for shipping to a burial ground. Glove boxes will be filled with a quicksetting foam material, packaged and shipped to a burial ground. Hot cells and manipulators will be disassembled, and compressed into steel drums. The actual handling and disposal methods will depend on the quantity of activity and the radiation characteristics. These methods will also determine the number of barrels needed for packaging, which in turn will greatly influence the disposal cost. An estimate of costs and manpower requirements for decommissioning (by DECON) various individual laboratories described in Section 14.1.2.1 is shown in Table 14.3-1. Decisions on the extent of dismantling and on discarding specific items will depend on the dollar value of the item and the cost and degree of difficulty of decontaminating it. These will be case-by-case decisions.

Actual packaging and shipping costs depend on the isotope involved. Iodine hoods, for example, may be decontaminated by wiping, but all the wastes have to be placed in packages that are surrounded by activated charcoal in a steel drum.

Decommissioning costs for manufacturing licensees with a large complex of facilities could be in excess of one million dollars.

Table 14.3-1 Summary of estimated requirements and costs for DECON of six reference laboratories that process or use radioisotopes

Parameter	Requirement or Cost for Reference Laboratory[a]					
	^{3}H Laboratory	^{14}C Laboratory	^{125}I Laboratory	^{137}Cs Laboratory	^{241}Am Laboratory	Institutional Laboratory
Time (days)	71	62	61	60	81	70
Manpower (man-days)	279	235	230	226	336	270
Occupational Dose[b] (man-rem)	0.1	0.001	0.1	6	40	0.1
Cost ($ thousands)[c]						
Staff Labor	65.4	55.3	53.6	53.3	78.6	63.3
Equipment	4.4	3.9	3.3	6.9	4.0	4.4
Supplies	8.1	10.0	9.2	9.1	11.2	8.9
Waste Management	66.4	52.1	39.9	32.2	49.6	52.2
Totals	144	121	106	102	143	129

[a] The listed value represents the requirement of cost for both planning and preparation and the actual decommissioning of the laboratory.

[b] Estimated on the assumption that workers do not use protective respiratory equipment. Doses could be reduced by 1 or 2 orders of magnitude through the use of this equipment. This is a likely alternative for the ^{241}Am laboratory.

[c] Costs are in 1986 dollars and include a 25% contingency.

Exposures to decommissioning workers will depend on the isotopes processed in a particular laboratory and on whether respirators and protective clothing are worn. At New England Nuclear, waste barrels are packed to measure no more than 250 mR/hr on the surface, or, if the waste has a very high radioactivity level, the barrel is kept to no more than 5 R/hr and it is kept shielded during handling and loading. Exposure of decommissioning workers is generally kept within operational exposure levels, and in no case is a worker allowed to receive more than 300 mrem/week[4].

The critical exposure time in decommissioning a laboratory is during the removal of the hoods, ventilation system, and hot cell. During this time, external exposure can be as high as 100 mrem/week. The remainder of the decommissioning time is spent in scrubbing hot spots. During this time, dose levels are at or below those encountered in operation of the laboratory (about 3 mrem/day). Occupational dose estimates for the reference individual facilities are also given in Table 14.3-1.

Examples of contamination which might exist at manufacturing facility sites were also considered. The manpower, cost, and dose estimates for decommissioning the reference contaminated sites described in Section 14.1.2.3 are given in Table 14.3-2.

Table 14.3-2 Summary of estimated manpower requirements, costs, and radiation doses for decommissioning three reference sites

	Requirement or Cost			
Site	Time (days)	Manpower (man-days)	Cost[a] ($ thousands)	Occupational Radiation Dose (man-rem)
Underground Drain Line & Hold-up Tank	17	72	67	0.04
Contaminated Ground Surface	42	203	1889	0.14
Tailings Pile				
Stabilization Option	32	174	251	0.08
Removal Option	139	1660	32,690	1.0

[a]Costs are in 1986 dollars and include a 25% contingency.

14.3.2.2 SAFSTOR

SAFSTOR is a reasonable alternative for decommissioning if the isotopes involved at a particular facility are short-lived and the facility has no other immediate planned usage. Use of a safe storage period of a few days to a few months may allow the radioactivity to decay to low enough levels that no further decontamination is required and that little action, perhaps only a radiation survey and some administrative action is necessary for releasing the facility for unrestricted use.

14.3.3 Decommissioning Alternatives for Broad Research and Development Program Facilities

Decommissioning a large R&D facility is a piecemeal operation because of the many separate working areas involved, although each area is relatively uncomplicated. The major activity in preparation for decommissioning will be the elimination of inventory. An accurate accountability system is difficult when such a large variety of laboratories and uses may be involved. Some laboratories may have small amounts of ^{14}C compounds, for example, left over from experiments conducted several years previously. Preparation for decommissioning must include an exhaustive inventory to discover these. The elimination of any inventory is the next step of decommissioning, which is carried out before the rest of the facility is decommissioned. The decommissioning alternatives considered are: DECON and SAFSTOR. These are discussed below.

14.3.3.1 DECON

A viable alternative for decommissioning an R&D laboratory is DECON. For many of the laboratories, this will not require discarding equipment. Most hoods, glove boxes, and ventilation systems can be decontaminated by washing. For laboratories where long-lived isotopes (^{3}H and ^{14}C) have been used over a period of several years, it may be sufficient to wash and paint the exposed surfaces or it may be desirable to discard some of the equipment as low-level waste. If they are to be discarded, the hoods and glove boxes will be painted to stabilize the surface contamination before dismantling. Ducts and other ventilation equipment parts will be placed inside the hoods and packaged for disposal at a low-level burial site.

Manpower, cost, and exposure estimates for the reference laboratory are included in Table 14.3-1.

A large university such as the University of Washington may have as many as 400 rooms where radioactive material is used. These include preparation rooms, experimental rooms, counting rooms, teaching laboratories, offices and storage rooms.

For many of these where only short-lived nuclides or sealed sources are used the major decommissioning action is a certification survey which would involve a couple man-days of effort.

Although it is unlikely that the entire complex would be decommissioned at one time, the total impacts for such a decommissioning would be on the order of ten times those of the reference facility with costs in the range of $250,000 - $1,000,000, and occupational dose of only about 1 man-rem.

14.3.3.2 SAFSTOR

For most of the laboratories at an R&D facility, this is the decommissioning alternative most likely to be employed. Except for ^{3}H and ^{14}C, the isotopes used at such a facility have short half-lives and a wait of a few days to a few months will allow the radioactivity to decay so that no further cleaning or dismantling is necessary. SAFSTOR assumes either that a laboratory can be left unoccupied for a time or that a survey indicates that the kinds and/or levels of radiation will permit people to work safely in the laboratory. The total cost of decommissioning will be that for extensive surveys to monitor decay of the radioactivity. This option will not apply to laboratories with long-lived isotope contamination. For a laboratory that has handled only ^{3}H or ^{14}C, DECON is probably the more viable alternative since these isotopes will not decay for many years. If several isotopes have been used in this same facility, it may be desirable to let the short-lived ones decay before decontaminating. Personnel exposure under this option will be negligible.

14.3.4 Decommissioning Alternatives for Processors of Radioactive Ore

The milling of nonradioactive metals by Kawecki Berylco Industries from ores containing uranium and thorium may contaminate the handling or milling equipment where the materials are retained by machinery. A simple cleanup and a survey are the only decommissioning actions required. As the materials are processed, most of the uranium and thorium remain with the sludge from the initial extraction, and the following decommissioning alternatives are considered for the sludges: removal (DECON), and neutralization and stabilization for long-term care.

14.3.4.1 Removal (DECON)

A potential decommissioning alternative is removal of the sludge from the milling site and disposal of it at a low-level waste burial ground. The effectiveness of this action could be enhanced by mixing lime into the sludge to neutralize any acid in it before depositing it where it might be contacted by water. Drawbacks to this option are the great amount of material that must be handled for the sake of a relatively small amount of radioactivity and the long distances that the material must be transported. Costs to transport and dispose of the sludge at a low-level waste burial ground 500 miles away, assuming that there are 90 million pounds of sludge, will be approximately 33 million in 1986 dollars (Table 14.3-2). The costs for transporting and burial are the major costs of disposal.

Radiation exposure to workers handling this sludge will be very similar to that of people working with uranium mill tailings piles. Radiation levels are 0.5 to 1.0 mrem per hour. Wearing respirators will reduce any problems from inhalation of particulates and leave only ^{222}Rn as a concern. Radon levels at the sludge site are also similar to levels at a tailings pile. Exposures and dose estimates to the workers and public are shown in Table 14.3-2.

This sludge could be disposed of in a local landfill if it did not exceed an acceptable residual radioactivity dose limit, which has yet to be determined.

Decontamination of the sludge by chemical removal of the uranium and thorium seems an attractive alternative, especially if the extraction costs are low enough that sale of the recovered uranium would return a profit or at least reduce the net cost of disposal. Previous milling practices may have affected the chemical nature of the uranium and thorium so that conventional milling methods will be ineffective. Any extraction process would have to remove thorium as well as uranium to make the sludge acceptable at a landfill.

14.3.4.2 Neutralization and Stabilization

This alternative is similar to preparation for safe storage and is followed by long-term care. The steps to accomplish this are to remove the roof, cover the pile with lime to neutralize residual acid, cover the entire structure with backfill, add a clay cap, cover with topsoil, and plant vegetation. The requirements for the kind and depth of cover will be similar to that for uranium tailings piles. However, while uranium mills and their tailings piles are generally located in the semi-arid western part of the U.S., the ore processing plants are likely to be found in areas where humidity and rainfall are much higher and the water table shallower. This will likely increase the need for protection against erosion, but vegetation to stabilize the surface will also grow better in this moister climate. This alternative may not be viable over a long term and would have to be considered on a case-by-case basis. Cost and radiation dose estimates for this alternative are shown in Table 14.3-2.

14.4 Environmental Consequences

There are other possible environmental consequences from decommissioning these kinds of facilities that cannot be reasonably discussed on a generic basis but have to be assessed for individual facilities. These include the effects on a local work force and on a local economy. The greatest impacts of this type will have occurred when the operations ceased and the effects of decommissioning will be minor by comparison.

The greatest terrestrial disturbance will come from decommissioning an ore processing facility, because of the large quantity of material involved. The alternative of stabilizing the tailings will require a large amount of earthen fill, the obtaining of which will necessitate digging up another area. Both the stabilized site and the borrow area will likely require reclamation and monitoring to prevent problems with erosion and surface water sedimentation. Of great concern with these facilities will be potential chemical toxicity from the processing chemicals and mobilized heavy metals in the tailings.

Both occupational and public exposure to radioactivity will be small for decommissioning a single facility. Although there are a large number of facilities, the potential dose from decommissioning all of the facilities is still expected to be relatively small.

14.5 Comparison of Decommissioning Alternatives

A comparison of decommissioning alternatives is highly specific for each kind of non-fuel-cycle facility. For most of the facilities that come under this designation, a removal of inventory will eliminate nearly all of the possibility of radiation exposure. The facilities discussed here are those that are perceived to have the greatest need for decommissioning action.

The most likely alternative for decommissioning most non-fuel-cycle facilities is DECON. In these facilities, radioactive contamination is low. Therefore, cleanup is not difficult. In some facilities, or parts of facilities where only short-lived isotopes have been used, delaying decontamination for a few weeks or months (SAFSTOR) may. allow all the radioactivity to decay and eliminate the need for actual decontamination operations leaving only a final survey to be done. Facilities where chemicals and pharmaceuticals have been formulated will require extensive cleaning of the inside building surfaces after the equipment has been removed. ENTOMB is not a practical decommissioning alternative for any of the kinds of facilities discussed here.

Stabilization with long-term care may be a viable alternative for disposal of radioactive tailings from an ore processing facility. These tailings are similar to uranium mill tailings and should be subject to the same requirements for stabilizing in place in comparable settings. The disposition of radioactive ore tailings (other than stabilization) has limited possibilities. Removal of the tailings to a low-level waste burial ground will be expensive but is feasible. Reprocessing to remove the radioactive elements from the sludge lacks practicality, mainly because the volumes and rates of production are not attractive to commercial processors.

Although there are thousands of non-fuel-cycle nuclear facilities and the reference facilities discussed here have significant costs and impacts, the overall impact of decommissioning non-fuel-cycle facilities is small. The reference facilities represent only the very few existing facilities which have significant impact while the large majority of the remaining facilities have impacts which are small or nonexistent. For example, approximately half of all the licensees are users of sealed sources and the environmental impacts of decommissioning these facilities are negligible. Also, most medical licensees (about 35% of all licensees) are for use of short-lived isotopes (and sealed sources), and the environmental impacts of these decommissionings would in most cases be very small. Hence, because most facilities have small environmental impacts due to decommissioning, the cumulative impact of decommissioning all of them is not significant.

REFERENCES*

1. Technology, Safety, and Costs of Decommissioning Reference Non-Fuel-Cycle Nuclear Facilities, Prepared by Pacific Northwest Laboratory for the U.S. Nuclear Regulatory Commission, NUREG/CR-1754, February 1981.

2. New England Nuclear Radioisotope Catalog, New England Nuclear Corporation, Boston, MA.

3. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. Nuclear Regulatory Commission, November 1976.

4. Handbook of Radiation Protection, Required Rules and Procedures, New England Nuclear Corporation, 1976.

*See footnote to reference in Chapter 1 for document purchasing availability.

15 NRC POLICY CONSIDERATIONS

At the end of the useful life of a licensed nuclear facility, the facility must be decommissioned. For such a facility, removal of the radioactivity to levels which permit unrestricted use of the facility (including the site) through decommissioning is necessary for full license termination. Present policy and regulatory guidance which addresses nuclear facility decommissioning is not specific enough to adequately assure that this desired objective is accomplished in a manner consistent with protection of the public health and safety. The NRC has been reevaluating its decommissioning policy[1] and considering amending its regulations to provide more specific requirements relating to the decommissioning of nuclear facilities. On February 11, 1985, the Commission published a Notice of Proposed Rulemaking on Decommissioning Criteria for Nuclear Facilities.[2] Addressed in this notice and the proposed rulemaking are reactors and associated fuel cycle facilities, and non-fuel-cycle facilities. Excluded from specific consideration in this plan and rulemaking are: (1) low-level waster burial facilities, which are separately addressed in regulations in 10 CFR Part 61; (2) Uranium mill and mill tailings, for which a Final EIS[3] is currently available and amended regulations have been promulgated; (3) High-level waste repositories, which will be covered in separate rulemaking; (4) Uranium mines and currently existing government owned enrichment plants, which are not under NRC jurisdiction.

As part of the decommissioning policy reevaluation and development of a series of NUREG reports (4-26), reports by Battelle Northwest Laboratory, Oak Ridge National Laboratory, other contractors, and by NRC staff have been developed. These reports are intended to serve as an information base for the development of decommissioning regulatory activities and contain information on technology, safety, and costs of decommissioning, on radiation termination surveys, and on financial assurance for decommissioning. In relation to such regulatory activities, an attempt has been made to maintain a dialogue with the public during development of rulemaking. This included public meetings, issuance of a draft environmental impact statement for public comment, and issuance of proposed rules for public comment. Based on the above information base and on consideration of the regulatory role NRC must provide in protecting public health and safety, the following conclusions appear evident:

(1) The technology for decommissioning nuclear facilities is well in hand and, while technical improvements in decommissioning techniques are to be expected, decommissioning at the present time can be performed safely and at reasonable cost. Radiation dose to the public due to decommissioning activities should be very small and be primarily due to transportation of decommissioning waste to waste burial facilities. Radiation dose to decommissioning workers should be a small fraction of their exposure experienced over the operating lifetime of the facility and usually be well within the occupational exposure limits imposed by regulatory requirements. Decommissioning costs are reasonable and are, at least for the larger facilities such as reactors, a small fraction of the present worth commissioning costs (i.e., less than 10%).

(2) Decommissioning of nuclear facilities is not an imminent health and safety problem. However, planning for decommissioning as an integral activity prior to commissioning as well as during facility life, is a critical item that can have an impact on health and safety as well as cost. Essential to such planning activity is reasonable assurance that funds will be available for performing required decommissioning activities at cessation of facility operation and of the facilitation of decommissioning, the decommissioning alternative to be used, as well as consideration of acceptable residual radioactivity levels for unrestricted use of the facility.

(3) Decommissioning of a nuclear facility generally has a positive environmental impact. At the end of facility life, termination of a nuclear license is a required objective. Such termination requires decontamination of the facility such that the level of residual radioactivity remaining in the facility or on the site is low enough to allow unrestricted use of the facility and site. Commitment of resources, compared to operational aspects, is generally small.

The major environmental impact of decommissioning is the commitment of small amounts of land for waste burial in exchange for reuse of the facility and site for other nuclear or nonnuclear purposes. Since in many instances, such as at a reactor facility, the land has valuable resource capability, return of this land to the commercial or public sector is highly desirable. In decommissioning of nuclear facilities, the objective of NRC regulatory policy is to ensure that for the commercial sector, proper and explicit procedures are followed in major key areas to mitigate any potential for adverse impact on public health and safety or on the environment.

In the following sections, major recommended regulatory positions are described with respect to decommissioning alternatives, planning, financial assurance, and residual radioactivity. In the final section, the manner in which such recommendations are to be explicitly incorporated into the regulatory process is discussed. A summary of the estimated radiation doses from decommissioning and costs of decommissioning for the facilities covered in this EIS is found in Tables 15.0-1 and 15.0-2.

15.1 Major Regulatory Particulars

15.1.1 Decommissioning Alternatives

Decommissioning means to remove a facility safely from service and to reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. This can be accomplished by decontamination and dismantling the facility for unrestricted use soon after cessation of operations. Alternatively, in certain situations for certain facilities, where the potential exists for occupational exposure and waste volume reduction (resulting from radioactive decay), or where there is an inability to dispose of waste because of lack of capacity, or for other site-specific factors which may affect health and safety, safe storage or entombment may be feasible.

Categorization of decommissioning alternatives is broken into three major classifications which are referred to in this EIS by the pseudoacronyms DECON, SAFSTOR, and ENTOMB. These terms have been used to discuss potential decommissioning

Table 15.0.1 Summary of Estimated Radiation Doses from Decommissioning Nuclear Fuel Cycle Facilities (in man-rem)

	DECOM	SAFSTOR			ENTOMB
		10 Years	30 Years	100 Years	
<u>Occupational Exposure/Facility(a)</u>					
Pressurized Water Reactor (PWR)	1,183(b)	652	329	304	920(c), 1,025(d)
Boiling Water Reactor	1,955	931	442	320	1,624(c), 1,753(d)
Fuel Reprocessing Plant	532	453	333	179	175
Small Mixed Oxide Plant	76	165	307	(e)	10
UF_6 Conversion Plant	1	1	1	1	(e)
Uranium Fuel Fabrication Plant	18.6	30	62	(e)	(e)
Non-Fuel-Cycle Facility	72	77	87	122	15
Independent Spent Fuel Storage Installation (ISFSI)	1,091	621	318	295	900(c), 1,000(d)
Multiple Reactor	72	77	87	122	15
<u>Public Exposure/Facility</u>(a)					
Pressurized Water Reactor (PWR)	21(b)	7	3	2	3(c), 4(d)
Boiling Water Reactor	10	5	2	2	5(c), 7(d)
Fuel Reprocessing Plant	19	15	10	4	3
Small Mixed Oxide Plant	4	4	4	4	1
UF_6 Conversion Plant	0(f)	0	0	0	(e)
Uranium Fuel Fabrication Plant	1	1	1	(e)	(e)
Non-Fuel-Cycle Facility	0	0	0	0	0(c), 0(d)
Independent Spent Fuel Storage Installation (ISFSI)	0	0	0	0	0
Multiple Reactor	0	0	0	0	0

(a) Data in this table calculated for the reference facilities as defined in the specific EIS section for that facility.
(b) Includes does due to transportation of wastes.
(c) With reactor internals included.
(d) With reactor internals removed.
(e) Not calculated.
(f) Means neligible dose.

Table 15.0.2 Summary of Estimated Costs for Decomissioning Nuclear Fuel Cycle Facilities (in Millions - based on 1986 Dollars)[a]

	DECON	SAFSTOR			ENTOMB
		10 Years	30 Years	100 Years	
Facility[b]					
Pressurized Water Reactor (PWR)	103.5	97.7	100.5	80.3	70.5[d], 60.2[c]
Boiling Water Reactor (BWR)	131.8	128.3	131.4	106.1	97.0[d], 84.7[c]
Fuel Processing Plant	169.0	181.0	187.0	205.0	(e) (e)
Small Mixed Oxide Plant	13.9	27.6	47.3	(e)	4.9
UF_6 Conversion Plant	12.1	15.1	17.6	26.4	(e)
Uranium Fuel Fabrication Plant	8.8	15.3	24.7	(e)	(c)

(a)Costs for specific facilities are based on References 1 through 8. Table includes costs for equipment, supplies, power, materials, waste, labor and services plus a 25% contingency factor. Costs do not include cost for demolition of nonradioactive structures.

(b)Data in this table calculated for the reference facilities as defined in the specific EIS section for that facility.

(c)With reactor internals included.

(d)With reactor internals removed.

(e)Not calculated.

alternatives in the nuclear facility studies presented in this report. Briefly, they have the following meanings:

DECON is the alternative in which the equipment, structures and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of facility operations.

SAFSTOR is the alternative in which the nuclear facility is placed (preparation for safe storage) and maintained (safe storage) in such condition that the nuclear facility can be safely stored and subsequently decontaminated to levels which permit release of the facility for unrestricted use (deferred decontamination). Depending on the radioactivity level at the end of the safe storage period, decontamination at the final stage may consist of only a radiation survey to verify that the radioactive constituents have decayed to an appropriate unrestricted access level.

ENTOMB is the alternative where at the end of facility life the equipment containing radioactive contaminants is encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the entombed radioactive contamination decays to a level permitting release of the facility for unrestricted use.

Based on an analysis of the technical data base, (4-26) decommissioning can be accomplished safely and at reasonable cost shortly after cessation of facility operation. DECON has certain benefits in that it would prepare the property for unrestricted use in a much shorter time period than SAFSTOR or ENTOMB with acceptable effects on occupational and public health and safety. Completing decommissioning and releasing the property for unrestricted use eliminated the potential problems that may result from an increasing number of sites contaminates with radioactive material, as well as eliminating potential health, safety, regulatory, and economic problems associated with maintaining the nuclear facility. The use of DECON assumes the availability of capacity to handle waste requiring disposal. The Federal and State governments have activities underway to assure that there will be this capacity.

Delay in the completion of decommissioning, as in the case of SAFSTOR or ENTOMB, would be acceptable primarily for reasons for occupational health and safety, since it is recognized that with delay there will be reduction in occupational dose and radioactive waste volume for some nuclear facilities due to radioactive decay. In addition, SAFSTOR may have some advantage where there are other operational nuclear facilities at the same site, and may also become necessary in other cases if there is a shortage of radioactive waste disposal space offsite. The appropriate delay will depend on the type of facility and the contaminant isotopes involved. One of the difficulties with ENTOMB for any complex structure such as a reactor is that the radioactive materials remaining in the entombed structure would need to be characterized well enough to be sure that they will have decayed to acceptable levels at the end of the surveillance period. If this cannot be done adequately, deferred decontamination would become necessary, which could make ENTOMB more difficult and costly than DECON and SAFSTOR.

The issue of timing concerns what amount of time would be appropriate to allow for completion of decommissioning including the entire period between final shutdown and license termination. The primary consideration is the decay of radioactivity which may result in reductions in occupational exposure and waste needing disposal. Facilities differ regarding the particular radionuclides most critical to decommissioning. For light water power reactors Co-60, with a half-life of 5.3 years, is the nuclide that has the most effect on decontamination efforts and is referred to as the critical/abundant nuclide. Other isotopes that can affect decommissioning efforts are Cs-137 (30-year half-life) and the long-lived isotopes Nb-94 and Ni-59.

As discussed above, a review of the technical data shows that, for DECON, occupational exposure can be kept reasonable. For example, studies indicate that occupational doses from decommissioning light water power reactors would be about 300 man-rem per year (1200-1900 man-rem over 6 years for large reactors). This is generally less than current annual doses at operating reactors. SAFSTOR will result in reduced occupational dose and amount of radioactively contaminated waste. Based on the half-life of the critical/abundant nuclide, the reduction of occupational doses beyond about 30 years would be marginally significant although a significant volume reduction in contaminated waste would result from 60 years in safe storage. It appears that DECON or SAFSTOR up to 60 years are reasonable options for decommissioning light water power reactors. Generally for reactors, the overall impact of either of these alternatives is similar, with the lower occupational dose and wastes with SAFSTOR compensating for the costs and uncertainties of controlling the site for a long period. The choice of alternative in individual cases will depend on a number of factors specific to the particular reactor, site, and time of decommissioning, for example, a longer SAFSTOR period may be acceptable if the safety of an adjacent reactor might be affected by dismantlement procedures or if there is an inability to dispose of waste due to lack of disposal capacity.

With regard to the ENTOMB alternative, long-lived activation products contained in reactor internals, such as Nb-94 (20,000 years half-life) and Ni-59 (80,000 years half-life), would probably preclude the use of ENTOMB for power reactors unless reactor internals were removed. If reactor internals are removed, some method would have to be provided to demonstrate that the entombed radioactivity will decay to levels permitting release of the property for unrestricted use within about 100 years, which, as noted above, would be difficult.

For research and test reactors and ISFSIs, occupational doses would be much less significant and much easier to manage than for power reactors. Thus, DECON is considered the most reasonable option. SAFSTOR could be justified in some cases. ENTOMB is not expected to be viable for ISFSIs and is also unlikely to be a reasonable option for non-power reactors as the cost would not be justified.

For materials facilities associated with licenses under Parts 30, 40, and 70, occupational doses are also quite low in most cases, and DECON the most likely option. SAFSTOR is possible for short-lived materials, but any extended delay would rarely be justifiable. For these reasons the amendments to Parts 30, 40, and 70 do not mention alternatives or have special requirements for extended delays. If after disposing of inventory and some preliminary decontamination, contamination from relatively short-lived materials is reported, the Commission will determine whether allowing a period for decay is an appropriate means of completing decommissioning. It is expected however, that for most licenses under these parts it will be practical to complete decontamination to levels suitable for unrestricted release prior to reporting levels of residual radioactivity to the Commission. A survey must be carried out and reported on promptly after the end of operations and prior to the expiration of the license.

15.1.2 Planning

15.1.2.1. Preliminary Planning

Planning for decommissioning is a critical item for ensuring that the decommissioning activities can be accomplished in a safe and timely manner. Development of detailed plans at the application stage is not possible because many factors (e.g., technology, regulatory requirements, economics) will change before the license period ends. Thus, most of the planning for the actual decommissioning will occur near final shutdown. However, a certain amount of preliminary planning should be done at the application stage.

The availability of adequate funds is important in assuring that decommissioning will be carried out in a safe and timely manner. There are also aspects of design and operations that could affect decommissioning in terms of improved health and safety and reduced radioactive waste such as ready access to major contaminated equipment.

Information on decommissioning funding provisions, described in section 15.1.3 must be submitted with an application for an operating license for a production or utilization facility. An application for an independent spent fuel storage installation will also include funding provisions. In the case of existing Part 50 licensees, information on funding provisions would need to be submitted within a reasonable time period following the effective date of this rule. This information should include the method of assuring funds for decommissioning and an indication of the amount being set aside. Provision should be made to adjust cost levels and associated funding levels over the life of the facility. In particular, Part 50 licensees must submit 5 years prior to the projected end of the operation an up-to-date cost estimate on which to base financial assurance. In this manner, it is expected that the amounts being assured by the funding method will reach a level at the end of life which is approximately equal to the actual costs of decommissioning. In particular, the cost estimate submitted at 5 years prior to end of operation would be based on a current assessment of major factors that could affect decommissioning costs. The requirement is intended to assure that Part 50 licensees shall consider relevant, up-to-date information which could be important to adequate planning and funding for decommissioning well before decommissioning actually begins.

For most facilities associated with licenses under Parts 30, 40, and 70, decommissioning is much less involved, and has much less impact than the decommissioning of a reactor, for example. However, for larger facilities, decommissioning funding provisions similar to those for reactors are necessary, although for most materials facilities with small decommissioning costs[2], submittal of information is not necessary.

The studies performed as part of the policy reevaluation have shown that facilitation of decommissioning in the design of a facility or during its operation can be beneficial in reducing operational exposures and waste volumes requiring disposal at the time of decommissioning. In addition, facilitation can improve financial assurance by keeping actual costs of decommissioning in line with the estimated costs on which the levels of financial assurance are based. The effects of operational procedures on decommissioning should be considered by licensees as part of their program to maintain radiation exposures and effluents "as low as is reasonably achievable" in existing 10 CFR Part 20. The facilitation of decommissioning in the design of facilities can be considered under the general standard for issuance of license that equipment and facilities be adequate to protect the health and safety of the public contained in §§ 30.33(a)(2), 40.32(c), 50.40(a), 70.23(a)(3), and 72.76. Suggestions for facilitation are presented in the PNL studies and in a preliminary study on facilitation of reactor decommissioning.

In particular, experience has shown that an important aspect of operation is the maintenance of adequate information on the design and current condition of the facility and site, so that decommissioning can be carefully planned and carried out. Records of relevant operational information helpful in facilitating decommissioning must be kept by all reactor and materials licensees. Plans should be developed to collect, maintain, and recall records and archive files which include as-built and as-revised drawings and specifications and operational occurrences which could significantly affect decommissioning so that important information is kept until termination of license and that it be readily accessible when needed.

15.1.2.2 Final Planning

Final decommissioning planning will involve greater technical detail than preliminary planning. Decommissioning plans should be submitted in a timely way for review and approval prior to the initiation of any major decommissioning activity to avoid delay of decommissioning after facility shutdown. For a power reactor, review and approval could take up to a year. Decommissioning plans must address the following:

(1) Decommissioning alternative - A description of the alternative to be used for decommissioning must be presented. Plans for processing and disposing of radioactive waste must also be described. Plans must assess the availability of waste disposal facilities. If waste disposal space is unavailable, then plans must address use of available temporary above-ground waste storage or other method. Depending on a variety of circumstances, temporary above-ground waste storage may be accomplished offsite or onsite and may require NRC review and approval.

(2) Technical and environmental plans - Controls and limits on procedures and equipment to ensure occupational and public safety and to protect the environment during decommissioning must be proposed by the licensee.

(3) A plan for a final radiation survey must also be presented to ensure that remaining residual radioactivity is within levels permitted for releasing the property for unrestricted use. Although the SAFSTOR or ENTOMB alternatives may have been selected, which would require a complete termination survey at some future time, unrestricted access to portions of the property may be desirable prior to full decommissioning. A separate termination survey would be necessary for these areas.

(4) An updated cost estimate must be included along with a plan to ensure that adequate decommissioning funds are available to carry out decommissioning operations.

(5) Quality assurance and safeguards - As appropriate for a particular facility, quality assurance and safeguards provisions during decommissioning must be addressed.

The NRC's evaluation of the information submitted in the decommissioning plan and the licensee's subsequent conduct of decommissioning activities can be based on existing regulations applicable to reactors and other facilities undergoing decommissioning. These regulations include 10 CFR Parts 20, 50, 61, 70, 71 and 73. For example, 10 CFR Part 20 contains standards for protection against radiation and is applicable to all licensees during operation as well as decommissioning.

15.1.3 Financial Assurance

The primary objective of the NRC with respect to decommissioning is to protect the health and safety of the public. An important aspect of this objective is that there is reasonable assurance that, at the time of termination of facility operations, adequate funds are available to decommission the facility in a safe and timely manner resulting in its release for unrestricted use and that lack of funds does not result in delays in decommissioning that may cause potential health and safety problems for the public. The need to provide this assurance arises from the fact that there are uncertainties concerning the availability of funds at the time of decommissioning. The nuclear facility licensee has the responsibility for completing decommissioning in a manner which protects public health and safety. Satisfaction of this objective requires that the licensee provide reasonable assurance that adequate funds for performing decommissioning will be available at cessation of facility operation.

In providing reasonable assurance that funds will be available for decommissioning, there are several possible financing mechanisms which are available to applicants and licensees. The wide diversity in different types of nuclear facilities necessitates that the NRC allow latitude in the implementation of these financing mechanisms. In analyzing funding methods, the NRC has developed the following major classification of funding alternatives.

(1) Prepayment - The deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash and liquid assets such that the amount of funds would be sufficient to pay decommissioning costs. Prepayment could be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

(2) Surety bonds, letters of credit, lines of credit, insurance, or other guarantee methods - These mechanisms guarantee that the decommissioning costs will be paid should the licensee default. The licensee still must provide funding for decommissioning through some other method. It appears questionable that surety methods of the size necessary and for the time involved with power reactors will be available. However, they appear to be available for facilities that involve smaller costs and periods. The contractual arrangement guaranteeing the surety methods, insurance, or

guarantee must include provisions for insuring that these methods will in fact result in funds being available for decommissioning. It should be kept in mind that sureties would only be called if at the time of cessation of facility operation or impending surety loss, licensee decommissioning funds were inadequate or unavailable.

(3) External Sinking Funds - A fund established and maintained by setting funds aside periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected. An external sinking fund could be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. The weakness of the sinking fund approach is that in the event of premature closure of a facility the decommissioning fund would be insufficient. Therefore, the sinking fund would have to be supplemented by insurance or surety bonds, or letters or lines of credit mechanisms of item (2).

(4) Internal Reserve or Unsegregated Sinking Fund - A fund established and maintained by the periodic deposit or crediting of a prescribed amount into an account or reserve which is not segregated from licensee assets and is within the licensee's administrative control in which the total amount of the periodic deposits or funds reserved plus accumulated earnings would be sufficient to pay for decommissioning at the time termination of operation is expected.

In this mechanism, the funds are not segregated from the utility's assets, rather they may be invested in utility assets and at the end of the facility life, internal funds are used to pay for decommissioning by, for example, issuance of bonds against licensee assets and the funds raised are used to pay for decommissioning. An internal reserve may also be in the form of an internal sinking fund which is similar to an external sinking fund except that the fund is held and invested by the licensee. Such a mechanism is generally considered to be less expensive in terms of net present value than the options listed above, although, as discussed in Section 2.6, whichever funding mechanism is used should not have a significant impact on the revenue requirements. The problem with the internal or unsegregated funding method is the lesser level of assurance that funds will be available to pay for decommissioning than the other mechanisms. Because this method depends on financing internal to the licensee, and therefore is vulnerable to events that undermine the financial solvency of a utility.

The NRC has considered the use of all of these methods (16-18, 20), and in particular internal reserve in several documents and has reviewed public comments on the proposed rule[2] and the draft GEIS. Based on these documents and on the discussion presented in more detail in Section 2.6.2 of this EIS, using a standard of providing reasonable assurance that sufficient funds are available for decommissioning, licensees may use the methods listed as (1) to (3) above singly or in combination. For electric utility licenses, because of their less vulnerable financial status as discussed in Section 2.6.2, the external sinking fund method of financing (3) would not require any additional assurance mechanism such as insurance or security bonds.

As discussed in 15.1.2.1, information on funding assurance provisions must be submitted by an applicant prior to licensing the facility. This information must include the method of assuring funds for decommissioning and an indication of the amount being set aside. To minimize administrative effort while still maintaining reasonable assurance of funds for certain facilities, the financial provisions may be based on an amount which is at least equal to amounts prescribed in the amended NRC regulations. These amounts vary for the different facilities covered by the regulations. Provisions should also include means for adjusting cost levels and associated funding levels over the life of the facility.

15.1.4 Residual Radioactivity Levels for Unrestricted Use of a Facility

Decommissioning requires reduction of the radioactivity remaining in the facility to residual levels that permit release of the facility for unrestricted use and NRC license termination.

The Commission is participating in an EPA organized interagency working group which is developing Federal guidance on acceptable residual radioactivity for unrestricted use. Proposed Federal guidance is anticipated to be published by EPA. NRC is planning to implement this guidance through rulemaking as soon as possible. The selection of an acceptable level is outside the scope of rulemaking supported by this EIS. Currently, criteria for residual contamination levels do exist and research and test reactors are being decommissioned using present guidance contained in Regulatory Guide 1.86 for surface contamination plus case-by-case considerations for direct radiation. As an example, NRC provided such criteria in letters to Stanford University, dated 3/17/81 and 4/21/82 providing "Radiation criteria for release of the dismantled Stanford Research Reactor to unrestricted access." The cost estimate for decommissioning can be based on current criteria and guidance regarding residual radioactivity levels for unrestricted use. As discussed in Section 2.5 of this EIS, the information in the studies by Battelle Northwest Laboratory and Oak Ridge National Laboratory on decommissioning have indicated that in any reasonable range of residual radioactivity limits, the cost of decommissioning is relatively insensitive to the radioactivity level and use of cost data based on current criteria should provide a reasonable estimate.

Even in situations where the residual radioactivity level might have an effect on decommissioning cost by use of update provision in the rulemaking, it is expected that the decommissioning fund available at the end of facility life will approximate closely the actual cost of decommissioning.

15.1.5 Environmental Impact Statement

Generally, the major environmental impact from decommissioning, especially for power reactors, occurs at commissioning, where the decision to operate the reactor is made. Provided the provisions of this rule are in place and based on the conclusion of Chapters 4 and 5 regarding impacts from reactor decommissioning alternatives, it is not expected that any significant environmental impacts will result from the choice of alternatives. Therefore current 10 CFR Part 51 needs to be amended to delete the mandatory EIS requirement for decommissioning of power reactors. An EIS may still be required but this should be based on site specific factors. Therefore a licensee should submit a supplemental environmental report and safety analysis and based on these submittals, the NRC should consider issuance of a negative declaration of impact, which is expected to be reasonable for most situations.

It is imperative that these decommissioning rule amendments in 10 CFR Parts 30, 40, 50, 51, 70 and 72 be issued at this time because it is important to establish financial assurance provisions, as well as other decommissioning planning provision, as soon as possible so that funds will be available to carry out decommissioning in a manner which protects public health and safety. Based on this need for the decommissioning rule and provisions currently existing and those contained in the rule amendments, the Commission believes that the rule can and should be issued now.

15.2 Regulations

As discussed in Section 15.1, consideration must be given to decommissioning of a facility during the design, construction and operating stages of a nuclear facility lifetime. Regulations which have relevance for decommissioning planning and accomplishment are contained in Title 10 of the Code of Federal Regulations (10 CFR), Parts:

Part No.	Title
30	Rules of General Applicability to Domestic Licensing of Byproduct Material
40	Domestic Licensing of Source Material
50	Domestic Licensing of Production and Utilization Facilities
51	Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions
70	Domestic Licensing of Special Nuclear Material
72	Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI)

Many of the regulatory requirements contained in the aforementioned regulations do not contain the explicit consideration of necessary decommissioning requirements discussed in this section (although many of the explicit decommissioning requirements have been required as a condition of NRC licensing in case-by-case instances). Development of a separate regulation which specifically addresses decommissioning was considered. However, such a separate regulation would be cumbersome because it would need to contain many of the requirements already presented in 10 CFR Parts 30, 40, 50, 51, 70, and 72. Since decommissioning requirements are an integral consideration in nuclear facility licensing and operation, it is appropriate in terms of simplicity, efficiency and reduction of regulatory burden, to amend the pertinent parts of the existing regulations to explicitly include appropriate decommissioning requirements.

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GLOSSARY

Abbreviations, acronyms, terms, and definitions used in this study and directly related to decommissioning work and related technology are defined and explained in this section. The section is divided into two parts, with the first part containing abbreviations and acronyms, and the second part containing terms and definitions (including those used in a special sense for this study). Common terms covered adequately in standard dictionaries are not included.

ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
ALAP	As Low As Practicable
ALARA	As Low As is Reasonably Achievable[a]
BEIR	Biological Effects of Ionizing Radiation
CFR	Code of Federal Regulations[a]
Ci	Curie[a]
DF	Decontamination Factor[a]
DOE	Department of Energy
DOT	Department of Transportation
DPM	Disintegrations per Minute[a]
EPA	Environmental Protection Agency
HEPA	High Efficiency Particulate Air (Filters)[a]
HLW	High Level Waste[a]
HVAC	Heating, Ventilation, and Air Conditioning
ICRP	International Commission on Radiological Protection
LLW	Low Level Waste[a]
m^3	Cubic Meters
mR	Milliroentgen[a]

[a] See the following section Glossary Definitions, for additional information or explanation.

mrad Millirad[a]

mrem Millirem, also see rem

MT Metric Ton[a]

MTHM Metric Ton of Heavy Metal

MWd/MTU Thermal Megawatt-day per Metric Ton of Uranium, the Burnup[a]

MWe Megawatts electric

MWt Megawatts thermal

NEPA National Environmental Policy Act

NRC Nuclear Regulatory Commission

ORNL Oak Ridge National Laboratory

OSF Overall Scaling Factor

PNL Pacific Northwest Laboratory

R Roentgen[a]

rad Radiation Absorbed Dose[a]

rem Roentgen Equivalent Man[a]

SNM Special Nuclear Material[a]

$T_{1/2}$ Half Life, Radiological[a]

TRU Transuranic

UF_6 Uranium hexafluoride

UO_2 Uranium dioxide

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[a] See the following section Glossary Definitions, for additional information or explanation.

GLOSSARY DEFINITIONS

Actinides--A series of heavy radioactive metallic elements of increasing atomic number (Z) beginning with antinium (89) or thorium (90) through element hahnium of atomic number 105.

Activation--The process by which a material is made radioactive by its exposure to neutrons or protons. Material in the primary coolant of a reactor may become activated in its passage through the reactor core. Also, the internals of a reactor may become radioactive due to their exposure to neutrons.

Activity--See Radioactivity.

Agreement State--A state with which the NRC has entered into an agreement, under provisions of the Atomic Energy Act of 1954 and its amendments, in which States assume regulatory responsibility over byproduct, source material, and small quantities of special nuclear material.

Airborne Radioactive Material--Radioactive particulates, mists, fumes, and/or gases in air.

ALARA--A regulatory design philosophy to maintain radiation exposure As Low As is Reasonably Achievable.

Atomic Number (Z)--The number of protons in the nucleus of an atom; also its positive charge. Each chemical element has its characteristic atomic number, and the atomic numbers of the known elements form a complete series from 1 (hydrogen) through 105 (hahnium).

Background--The level of radioactivity from sources other than the one directly under consideration, in this case those existing without the presence of the nuclear facility.

Beta Decay--Radioactive decay in which a beta particle is emitted or in which an orbital electron capture occurs.

Bio-availability--The degree to which radionuclides are available for transmittal through the food chain to the exposed individual.

Burial Grounds--Areas designated for storage of packaged radioactive wastes in soils below the surface.

Burnup, Specific--The total energy released per unit mass of a nuclear fuel. It is commonly expressed in megawatt-days per metric ton of fuel material.

Byproduct Material--Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

Cask--A heavily shielded shipping container for radioactive materials. Some casks weigh as much as 100 metric tons.

Certification survey--See terminal radiation survey.

Chemical decontamination--Decontamination accomplished by the use of chemical solutions to remove surface films containing radioactive materials.

Code of Federal Regulations (CFR)--The Code of Federal Regulations is a documentation of the general rules by the Executive departments and agencies of the Federal Government. The Code is divided into 50 titles that represent broad areas subject to Federal regulation. Each title is divided into Chapters that usually bear the name of the issuing agency. Each Chapter is further subdivided into Parts covering specific regulatory areas.

Commissioning--The licensing and startup of a nuclear facility.

Container--See cask.

Contamination--Undesired radioactive materials that have been deposited on the surfaces, or are internally ingrained into structures or equipment, or that have been mixed with other materials.

Continuing care--See safe storage.

Critical Facility--A non-reactor facility that handles, tests or processes fissile material.

Curie--A special unit of radioactivity. One curie equals 3.7×10^{10} nuclear transformations per second. (Abbreviated Ci.) Several fractions of the curies are in common usage:

- Millicurie. One-thousandth of a curie. Abbreviated mCi (3.7×10^{7} d/s).
- Microcurie: One-millionth of a curie. Abbreviated μCi (3.7×10^{4} d/s).
- Nanocurie: One-billionth of a curie. Abbreviated nCi (37 d/s).
- Picocurie. One-millionth of a microcurie. Abbreviated pCi (0.037 d/s).

Custodial SAFSTOR--A minimum cleanup and decontamination followed by a period of safe storage with active protection systems in service and completed by deferred decontamination. The active protection systems (i.e., principally ventilation) are kept in service, the site is secured against intrusion by physical barriers and by guards, and use of the facility and site is limited to nuclear activities.

Decay, Radioactive--A spontaneous nuclear transformation in which a particle, gamma radiation, or x-ray radiation is emitted.

Decommissioning--To remove a facility safely from service and reduce residual radioactivity remaining to a level that permits release of the property for unrestricted use and termination of license.

Decommissioning insurance--A mechanism for assuring the funding of decommissioning which could provide funds for all decommissioning expenses, including those for premature closure of the facility, or alternatively, funds to cover costs of premature decommissioning in the event that other mechanisms provided by the insureds were insufficient.

DECON--The alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.

Decontamination--Those activities employed to reduce the levels of contamination in or on structures, equipment and materials.

Decontamination Factor (DF)--The ratio of the initial concentration of an undesired material to the final concentration resulting from a treatment process. The term may also be used as a ratio of quantities.

Deferred Decontamination--Those actions required after the safe storage period of SAFSTOR to disassemble and remove sufficient radioactive or contaminated materials from the facility and site to permit release of the property for unrestricted use.

Design Basis Accident--A postulated accident believed to have the most severe expected impacts on a facility. It is used as the basis for safety and structural design.

Disintegration, Nuclear--The transformation of the nucleus of an atom from one element to another, characterized by a definite half-life and the emission of particles or electromagnetic radiation.

Disintegration Rate--The rate at which disintegrations occur, characterized in units of inverse time, i.e., disintegrations per minute (dpm), etc.

Dismantlement--Those actions required to disassemble and/or remove radioactive or contaminated materials from the facility and site.

Dispersion--A process of mixing one material within a larger quantity of another. For example, the mixing of material released to the atmosphere with air causes a reduction in concentration with distance from the source.

Disposal--The disposition of materials with the intent that the materials will not enter man's environment in sufficient amounts to cause a health hazard.

Dose, Absorbed--The mean energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad. One rad equals 0.01 joules/kilogram in any medium (100 ergs per gram).

Dose commmitment--The integrated dose that results unavoidably from an intake of radioactive material starting at the time of intake and continuing to a later time (usually specified to be 50 years from intake).

Dose, Equivalent--Expresses the amount of radiation that is effective in the human body, expressed in rems. Modifying factors associated with human tissue and body are considered. Equivalent dose is the product of absorbed dose multiplied by a quality factor multiplied by a distribution factor. Referred to as Dose in this report.

Dose, Occupational--The exposure of an individual to radiation as a result of his employment, expressed in rems.

Dose Rate--The radiation dose delivered per unit time and measured, for instance, in rem per hour.

Enrichment--The ratio (usually expressed as a percentage) of fissile isotope to the total amount of the element (e.g., the % of ^{235}U in uranium).

ENTOMB--The alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting unrestricted release of the property.

Exposure--The condition of being made subject to the action of radiation; also frequently the quantity of radiation received. The special unit of exposure is the roentgen (see Roentgen).

Exposure Pathway--The mechanisms by which radioactive material passes from the source of the material through the environment to an exposed individual.

External exposure--As used in this EIS, an exposure pathway in which an individual is externally exposed directly to radioactive materials dispersed in the air (immersion) or is exposed directly to surfaces containing radioactive materials.

Facilitation--As used in the context of decommissioning, consideration to be given to facility design and normal operational procedures, as well as decommissioning procedures, with the primary purpose of reducing occupational and public radiation dose and waste volumes during the decommissioning process.

Facility--The physical complex of buildings and equipment within a site.

Final Inventory Cleanout--An extensive inventory cleanout and special nuclear material audit conducted upon termination of normal facility operations. Since these cleanout operations are also conducted periodically during normal operation for audit and contamination control purposes, this procedure is not considered part of decommissioning and its cost is not included as a decommissioning cost.

Fission--The splitting of a heavy atomic nucleus into two lighter parts (atomic nuclides of lighter elements), accompanied by the release of a relatively large amount of energy and generally one or more neutrons. Fission can occur spontaneously but usually it is caused by nuclear absorption of neutrons or other particles.

Fissile Materials--Materials that are capable of fission.

Fission Products--The lighter atomic nuclides (fission fragments) formed by the fission of heavy atoms. It also includes the nuclides formed by the fission fragments' radioactive decay.

Food Chain--The pathways by which any material passes through man's environment through edible plants and/or animals to man.

Fuel Assembly--A grouping of fuel elements (hollow rods filled with nuclear fuel for LWRs) that supply the nuclear heat in a nuclear reactor. A fuel element or rod is the smallest structurally discrete part of a reactor or fuel assembly that has nuclear fuel as its principal constituent.

Fuel Cycle--The series of steps involved in supplying fuel for nuclear power reactors and handling spent fuel and radioactive waste, including transportation. These steps are usually divided up as the head end and back end as follows:

Head end: Mining, milling, conversion, enrichment, and fabrication of fuel.

Back end: Includes reactors, spent fuel storage, spent fuel reprocessing, mixed-oxide fuel fabrication, and waste management.

Fuel Element--A rod, tube, or other form into which nuclear fuel is fabricated to use in a reactor.

Gamma Rays--Short-wavelength electromagnetic radiation. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are best stopped or shielded against by dense materials such as lead or uranium. These rays originate from within the nucleus of the atom.

Gaseous--Material in the vapor or gaseous state, but can include entrained liquids and solids. A gas will completely fill its container regardless of container shape or size.

Half-Life, Radioactive--The time in which half the atoms of a particular substance disintegrates to another nuclear form. Each radionuclide has a unique half-life. Measured half-lives vary from millionths of a second to billions of years.

Heavy Metal--Terminology used in reference to metals with atomic numbers 90 and greater. It usually refers to nuclear fissile or fertile fuels such as thorium, uranium, and plutonium.

HEPA filter--A filter used in facility ventilation systems whose purpose is to remove particulate material from the ventilation air stream.

High-Level Wastes--Intact fuel assemblies that are being discarded after having completed their useful lives in a nuclear reactor (spent fuel) or the portion of the wastes generated in the reprocessing of spent fuel that contain virtually all of the fission products and most of the actinides not separated out during reprocessing.

Hot Spots--Areas of radioactive contamination higher than average.

Ingestion--As used in this EIS, an exposure pathway in which radioactive materials reach the exposed individual through the ingestion of food and water.

Inhalation--As used in the EIS, an exposure pathway in which radioactive materials reach the exposed individual through the breathing process.

Institutional Control Reliance--The degree to which reliance can be placed on the ability of man-made institutions to both safely confine the radioactivity in and prevent ~~the intrusion~~ into a nuclear facility while it is in safe storage or while it is entombed.

Insurance for decommissioning--See decommissioning insurance.

Internal reserve--A mechanism for the funding of decommissioning in which a fund is established and maintained by the periodic deposit or crediting of a prescribed amount into an account or reserve which is not segregated from licensee assets and is within the licensee's administrative control in which the total amount of the periodic deposits or funds reserved plus accumulated earnings would be sufficient to pay for decommissioning at the time termination of operation is expected.

Ion Exchange--A chemical process involving the selective adsorption or desorption of various chemical ions in a solution onto a solid material, usually a plastic or resin. The process is used to separate and purify chemicals, such as fission products from plutonium or "hardness" from water (i.e., water softening).

Licensed Material--Nuclear source material, special nuclear material, or nuclear by-product material received, possessed, used, or transferred under a license issued by the Nuclear Regulatory Commission.

Long-Lived Nuclides--For this study, radioactive isotopes with long half-lives typically taken to be greater than about ten years. Most nuclides of interest to waste management have half-lives on the order of one year to millions of years.

Low-Level Wastes--Wastes contaminated with radioactive materials emitting primarily beta or gamma radiation, not high-level waste (see high-level wastes) and which are not transuranic wastes, i.e., they contain less than 10 nanocuries per gram of transuranic elements (see transuranic waste).

Management (Waste)--The planning, execution, and surveillance of essential functions related to radioactive waste, including treatment, solidification, packaging, interim or long-term storage, transportation, and disposal.

Man-rem--A measure of radiation dose distributed to a population. To calculate radiation dose to the population, the dose equivalent in rem received by each person in the population is summed.

Mass Number--The number of nucleons (protons and neutrons) in the nucleus of an atom. (Symbol: A).

Maximum Exposed Individual--The hypothetical member of the public who receives the maximum radiation dose. For the common case where exposures from airborne radionuclides result in the highest radiation exposure, this individual resides at the location of the highest airborne radionuclide concentration and eats food grown at that location.

Megawatt-day--A unit for expressing the energy generated in a reactor; specifically, the number of millions of watt-days of heat output per metric ton of fuel in the reactor. Also, the net electrical output in millions of watts of electrical energy averaged over one day.

Megawatt Days per Metric Ton of Uranium--Amount of thermal megawatt-days produced per metric ton of uranium; also called burnup. (See also specific power.)

Metric Ton--1000 kilograms.

Mixed Oxide--A mixture of uranium dioxide and plutonium dioxide.

Monitoring--Taking measurements or observations for recognizing the status, or significant changes in conditions or performance, of a facility or area.

Negative Net Salvage Value Depreciation--An accounting procedure which allows depreciation to be collected in a manner that considers that the salvage value of a nuclear facility is actually negative, i.e., the price of any salvageable equipment is outweighed by the cost of decommissioning. Thus the net depreciation value of a nuclear facility is its original capital cost plus its decommissioning cost.

Net present worth--As used in this EIS, the cost of decommissioning in terms of 1986 dollars.

Normal Operating Conditions--Operation (including startup, shutdown, and maintenance) of systems within the normal range of applicable parameters of an operating facility.

Nuclear Reaction--A reaction involving a change in an atomic nucleus, such as fission, fusion, particle capture, or radioactive decay.

Offsite--Beyond the boundary line marking the limits of plant property.

Onsite--Within the boundary line marking the limits of plant property.

Operable--Capable of performing the required function.

Package--The packaging plus the contents of radioactive materials.

Packaging--The assembly of radioactive material in one or more containers or other components necessary to assure compliance with prescribed regulations.

Passive SAFSTOR--A partial cleanup and decontamination effort initially, followed by a period of safe storage and completed by deferred decontamination. During the period of safe storage, all systems are deactivated, the structures are secured by strong physical barriers and continuous remote monitoring, and the plant is limited to nuclear use only, while the site may have non-nuclear uses.

Physical decontamination--Decontamination accomplished by the use of mechanical cleaning means or by the removal of the surface itself.

Plant--The physical complex of buildings and equipment, including the site.

Preparation for Safe Storage--Those cleanup and decontamination activities required during the initial stages of SAFSTOR in order to prepare the facility for the safe storage period.

Prepayment--A mechanism for the funding of decommissioning in which there is a deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets such that the amount of funds would be sufficient to pay decommissioning costs.

Protective Clothing--Special clothing worn by a person in a radioactively contaminated area to minimize the potential for contamination of his body or personal clothing and to control the spread of contamination.

Quality Assurance--The systematic actions necessary to provide adequate confidence that a material, component, system, process, or facility performs satisfactorily, or as planned, in service.

Quality Control--The quality assurance actions that control the attributes of the material, process, component, system or facility in accordance with predetermined quality requirements.

Rad--A unit of absorbed dose. The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. One rad equals 0.01 joule/kilogram of absorbing material.

Radiation--(1) The emission and propagation of radiant energy through space or through a material medium in the form of waves; for instance, that of electromagnetic waves or of sound and elastic waves. (2) The energy of such waves; and (3) corpuscular emissions, such as alpha and beta radiation, or rays of mixed or unknown types.

Radiation Background--See Background.

Radioactive Material--Any material or combination of materials which spontaneously emit ionizing radiation, generally alpha or beta particles, often accompanied by gamma rays.

Radioactivity--The number of nuclear transformations occurring in a given quantity of material per unit of time with the emission of particles, gamma radiation, or x-ray radiation. Often shortened to "activity."

Radioactivity, Natural--The property of radioactivity exhibited by more than fifty naturally occurring radionuclides.

Radiological Protection--Protection against the effects of internal and external exposure to radiation and to radioactive materials.

Rate of return--As used in this EIS, the rate that investment by decommissioning funding mechanisms will increase in value.

Regulatory Guides--Regulatory Guides are issued by the NRC, to describe and make available to the public, methods acceptable to the NRC staff, for implementing specific parts of the NRC's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide other guidance to applicants for nuclear operations. Guides are not substitutes for regulations and compliance with them is not explicitly required. Methods and solutions different from those set out in the guides may be acceptable if they provide a basis for the finding requisite to the issuance or continuance of a permit or license by the NRC.

Rem--A unit of radiation dose equivalence. The radiation dose equivalence in rem is numerically equal to the absorbed dose in rads multiplied by the quality factor, the distribution factor, and any other necessary modifying factors.

Respository (Federal)--A site owned and operated by the Federal Government for long-term storage or disposal of radioactive materials.

Residual Radioactivity Levels--As used in this EIS, the amount of radioactively contaminated material remaining in a nuclear facility after decommissioning has been completed and the facility license terminated. To be acceptable, this level must be low enough to permit the facility to be released for unrestricted use.

Restricted Area--Any area to which access is controlled for protection of individuals from exposure to radiation and radioactive materials.

Risk--As used in this EIS, quantitative risk estimation of potential health effects.

Roentgen--A unit of exposure to ionizing radiation. It is that amount of gamma or x-rays required to produce ions carrying one electrostatic unit of electrical charge (either positive or negative) in one cubic centimeter of dry air under standard conditions. One roentgen equals 2.58×10^{-4} coulombs per kilogram of air. (See also Exposure.)

SAFSTOR--The alternative in which the nuclear facility is placed (preparation for safe storage) and maintained in a condition that allows the nuclear facility to be safely stored (safe storage) and subsequently decontaminated to levels that permit release for unrestricted use (deferred decontamination).

Safe Storage--A period of time starting after the initial decommissioning activities of preparation for safe storage cease and in which surveillance and maintenance of the facility takes place. The duration of time can vary from a few years to on the order of 100 years.

Sealed source--Radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.

Segregated funding mechanism--As used in this EIS, a term to indicate that the funding mechanism being employed deposits funds in accounts separate from company assets and under control of a party other than the licensee.

Shield--A body of material used to reduce the passage of particles or electromagnetic radiation. A shield may be designated according to what it is intended to absorb (as a gamma ray shield or neutron shield), or according to the kind of protection it is intended to give (as a background, or thermal shield). It may be required for the safety of personnel or to reduce radiation enough to allow use of counting instruments for research or for locating contamination or airborne radioactivity.

Short-Lived Radionuclides--For this study, those radioactive isotopes with half-lives less than about 10 years.

Shutdown--The time during which a facility is not in productive operation.

Sinking Fund--A mechanism for the funding of decommissioning in which a prescribed amount of funds, subject to periodic revision, is set aside at regular intervals such that the fund plus accumulated interest would be sufficient to pay for decommissioning costs at the end of facility operation.

Site--The geographic area upon which the facility is located that is subject to controlled public access by the facility licensee (includes the restricted area designated in the NRC license).

Solid Radioactive Waste--Material that is essentially solid and dry but may contain sorbed radioactive fluids in sufficiently small amounts as to be immobile.

Solidification--Conversion of radioactive wastes (gases or liquids) to dry, stable solids.

Special Nuclear Material--Plutonium, uranium enriched in the isotopes 233 or 235, and any other material as defined in 10 CFR 70 by the NRC.

Surety bond--A mechanism for the funding of decommissioning which guarantees that decommissioning costs will be paid should the bond purchaser default.

Surface Contamination--Contamination that is the result of the deposition and attachment of foreign materials to a surface.

Surveillance--Those activities necessary to assure that the site remains in a safe condition (including inspection and monitoring of the site, maintenance of barriers to access to radioactive materials left on the site, and prevention of activities on the site that might impair these barriers).

Survey--An evaluation of the radiation hazards incident to the production, use, release, disposal or presence of radioactive materials or other sources of radiation under a specific set of conditions.

Technical Specifications--Requirements and limits that encompass nuclear safety but are simplified to facilitate use by plant operation and maintenance personnel. They are prepared in accordance with the requirement of 10 CFR 50.36, and are incorporated by reference into the amended license issued by the NRC.

Terminal Radiation Survey--The radiation survey conducted near the end of the decommissioning period the purpose of which is to certify that decommissioning of the facility has resulted in residual radioactivity levels acceptable for releasing the facility for unrestricted use.

Transuranic Elements--Elements with atomic number (Z number) greater than 92.

Transuranic Waste--Any waste material measured or assumed to contain more than a specified concentration (i.e., proposed as 10 nanocuries of alpha emitters per gram of waste, or more presently proposed as 100 nanocuries/cm^3 of waste ^{239}U) of transuranic elements.

Unfunded reserve--See internal reserve.

Unrestricted access--The condition of a nuclear facility after decommissioning is complete and the facility license is terminated. At this time the general public would be allowed use of the facility without radiation protection controls.

Unsegregated sinking funds--See internal reserve.

Volumetric contamination--Contamination that is contained within the volume of the contaminated material, such as activation products.

Wastes, Radioactive--Equipment and materials (from nuclear operations) that are radioactive and for which there is no further known use.

Whole Body Dose Equivalent--As used in this report for the discussion of residual radioactivity levels, a single dose equivalent number that is a summation of dose equivalent from major organs multiplied by respective weighting factors related to cancer producing risk.

APPENDIX A. DISCUSSION OF COMMENTS ON THE DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT

In a Federal Register notice, 46 FR 27, dated February 10, 1981, the Commission announced the availability of a Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, and invited public comment on the statement. Comments received on the Draft GEIS are reproduced in Appendix B of this Final GEIS.

The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by revisions in the pertinent sections of this Final GEIS and in part by the following discussions. This section is organized according to major identified questions or subject areas. These areas are those indicated in Chapters 1 and 2 of the Draft GEIS. These subject areas and the sections of Appendix A in which they are covered are as follows:

Subject Area	Section
General Questions about Decommissioning Regulations and the GEIS	A-1
Planning for Decommissioning	A-2
Decommissioning Alternatives and Other Design Issues	A-3
Residual Radioactivity	A-4
Financial Assurance	A-5
Waste Disposal	A-6
Other general questions	A-7

These general subject areas are broken down in more detail in each of the sections. Discussions on the comments on similar topics are grouped together. The comment letters to which the discussions apply are referenced by the number following the title of each response; these numbers are keyed to the letters in Appendix B, Table B-1.

On February 11, 1985, the NRC published a Notice of Proposed Rulemaking on Decommissioning Criteria for Nuclear Facilities (50 FR 5600). The proposed amendments covered a number of topics related to decommissioning that would be applicable to 10 CFR Parts 30, 40, 50, 70, and 72 applicants and licensees. These topics included decommissioning alternatives, planning, assurance of funds for decommissioning, environmental review requirements, and residual radioactivity. A total of 143 different organizations and persons submitted comments on the proposed rule. Detailed responses to those individual comments are documented in NUREG-1221 entitled "Summary, Analysis and Response to Public Comments on Proposed Rule Amendments on Decommissioning Criteria for Nuclear

Facilities." Many of the comments made on the proposed rule are similar to those made on the Draft GEIS and hence the responses are the same. To minimize repetitiveness, in responding to the Draft GEIS comments in this Appendix A, reference is made to NUREG-1221, as appropriate, for a more complete discussion.

A.1 General Questions About Decommissioning Regulations and the GEIS

A.1.1 Need for Regulations

Comment No. 1 - Questions why the GEIS does not present the needed decommissioning regulations. (1, 3, 32, 36, 40)

Discussion

The GEIS itself does not present the decommissioning regulations. However, as indicated in Section 1.1 of the Draft GEIS, the purpose of the GEIS is to assist the NRC in developing new policies and in promulgating regulations with respect to decommissioning of licensed nuclear facilities. In Chapter 15, the GEIS contains recommended policy items that should be included in decommissioning regulations. On February 11, 1985, the NRC published a Notice of Proposed Rulemaking on Decommissioning Criteria for Nuclear Facilities (50 FR 5600). The proposed amendments would be applicable to 10 CFR Parts 30, 40, 50, 70, and 72 applicants and licensees and covered decommissioning alternatives, planning, assurance of funds for decommissioning, and environmental review requirements. Final regulations based on the proposed rule and public comment on that rule and incorporating conclusions of the Final GEIS will be issued as effective at the time that the Final GEIS is published.

Comment No. 2 - Raises the question that current regulations on decommissioning are adequate, that the NRC has not indicated why new or amended regulations are needed, and that decommissioning criteria should be applied on a case-by-case basis. (16, 23, 25, 34, 35)

Discussion

Currently, regulations and guidance pertaining to decommissioning of the facilities covered by this EIS are contained only within 10 CFR Parts 50 and 72, and in Regulatory Guide 1.86 and in similar NRC staff guidelines. However, as discussed in the Draft GEIS Section 15 many of the existing regulatory requirements do not contain sufficiently specific consideration of necessary decommissioning requirements to assure that decommissioning is accomplished in a manner which protects the health and safety of the public (although many of the requirements have been required as a condition of NRC licensing in case-by-case instances). There is need for more specific guidance especially in such areas as assurance of funding, decommissioning alternatives, planning for decommissioning and environmental review requirements.

In the area of funding, the Commission has recently deleted requirements (see 46 FR 40) for financial qualification for electric utilities from 10 CFR 50.33(f) and 10 CFR Part 50 Appendix C, with the proviso that there be rulemaking on specific requirements for funding of decommissioning in the near future. In addition, there is a need for funding requirements for materials facilities because of problems arising from licensees' lack of funds for decommissioning and abandoning contaminated facilities. In the area of planning for decommissioning, there is a need for recordkeeping requirements so that decommissioning can be carried out in a manner which keeps occupational and public radiation exposures as low as reasonably achievable. In the area of decommissioning alternatives, there is a need for criteria as to what alternatives for completing decommissioning are considered acceptable.

It is the intention of the amended regulations to provide for specific guidance and consistent licensing effort for all facilities licensed by NRC. More detail on these areas are contained in NUREG-1221, Sections B.3.1, C.7.1, D.8.1, E.1, and G.1.

Comment No. 3 - Indicates that there should be flexibility in the proposed decommissioning rules and that rules for reactors may not be applicable to materials facilities. (8, 23, 31)

Discussion

It is NRC's intention that the rule amendments on decommissioning contain sufficient flexibility to take into account individual situations while still maintaining consistency in the overall licensing criteria. That this is the intention should be evident in such Draft GEIS sections such as 15.1.1 (which indicates the bases upon which different decommissioning alternatives could be used), and in Section 15.1.3 (which indicates that NRC will allow latitude in the implementation of financing mechanisms due to the wide diversity in different types of nuclear facilities). More detail on these areas are contained in NUREG-1221, Sections B.4.2, D.3.1, and G.3.

Comment No. 4 - Questions whether regulations are needed at this time since there is not a large number of facilities now nearing the end of their useful lives. (23)

Discussion

Regulations are needed at this time to ensure that certain activities are initiated that are needed at this time to prepare for decommissioning. Specifically, this includes such activities as providing assurance for the funding of decommissioning, (for all types of facilities including reactors, fuel cycle facilities, and materials facilities) and planning for the facilitation of decommissioning, specifically recordkeeping. In addition, there is a sufficient number of different types of facilities that are now, or in the near future, undergoing decommissioning and hence consistent criteria for accomplishing their decommissioning is needed.

Comment No. 5 - Raises the question that there should be separate rulemaking for premature decommissioning including that resulting from accidents. (23)

Discussion

The proposed amendments apply to nuclear facilities that operate through their normal lifetime, as well as to those that may be shut down prematurely. This is consistent with the definition of decommissioning as presented in EIS Section 2.3. However, the activities following premature shutdown of a facility as a result of an accident are somewhat different than those of a routine decommissioning. There are three stages involved: a stabilization period, during which accident conditions are brought under control if necessary; an accident cleanup period: and a decommissioning period. During the accident cleanup, the major portion of contamination resulting from the accident is cleaned up and the associated wastes are processed. Following accident cleanup, the facility may either be recovered for reuse or be decommissioned. A detailed study of reactor decommissioning following accident cleanup (NUREG/CR-2601-Reference 7) indicated that there may be differences in some of the specific aspects of decommissioning such as the spread of contamination, waste volumes, exposures, and costs. However, the report also indicates that the technology exists to accomplish the decommissioning and that the safety and costs of decommissioning following the accident cleanup do not vary significantly from that following normal operations.

Comment No. 6 - Questions whether a separate decommissioning regulation should be prepared rather than incorporating into existing parts. (34)

Discussion

Section 15.2 of the Draft GEIS and reprinted in this Final GEIS indicates the reasons for incorporating the regulations into existing parts.

A.1.2 Applicability of Regulations to Existing Facilities

Comment No. 1 - Questions whether proposed regulations should be applied to existing facilities and indicates that less stringent criteria should be applied. (16)

Discussion

The general criteria of the regulations will be applicable to all facilities. Thus the general provisions of funding, alternatives, and planning are applicable so that there is consistency in criteria. Specific requirements in these areas will allow for a reasonable period of time before funding assurance provisions must be instituted at existing facilities while recordkeeping provisions should be instituted following the rule becoming effective. Specific problems related to situations at existing facilities will be considered, most likely in regulatory guidance. More detail with regard to facilities already shut down is contained in NUREG-1221, Sections C.9 and D.4.6.3.

A.1.3 Need for Cost-Benefit Analysis in Regulations

Comment No. 1 - Raises the question that the regulations being considered have not been supported by an adequate cost-benefit analysis or value/impact analysis. (15, 16, 24, 34)

Discussion

A separate regulatory analysis has been submitted with the proposed decommissioning rulemaking (issued February 11, 1985) and a modified regulatory analysis supporting final rule requirements will be issued dealing with appropriate cost benefit analysis resulting from implementation of the rule.

Comment No. 2 - Raises the question that the proposed regulations will have an adverse impact on the nuclear industry. (16)

Discussion

Based on the conclusions of the DGEIS and FGEIS (Chapter 15) and the regulatory analysis in support of the rulemaking referred to in response to Comment No. 1 immediately above, it is concluded that rulemaking can be optimally implemented to assure health and safety requirements with a minimum of impact on the nuclear industry and generally will have a beneficial impact.

A.1.4 General Comments on GEIS Document

Comment No. 1 - Questions whether the GEIS document should treat so many different facilities. (16)

Discussion

As discussed in the response to Comments No. 1, 2 and 3 in Section A.1.1, the purpose of the GEIS is to assist the NRC in developing new policies with respect to decommissioning all licensed nuclear facilities, and specifically in such a manner that these policies be implemented so that there is consistency in overall licensing and regulatory criteria while still maintaining sufficient flexibility to take into account the diversity in types of facilities.

Comment No. 2 - Questions whether the GEIS should establish standards properly within the province of EPA. (16)

Discussion

As discussed in Section 2.5 of the FGEIS, selection of an acceptable residual radioactivity level is outside the scope of the rulemaking supported by this EIS. Proposed Federal Guidance is anticipated to be published by EPA and the NRC is planning to implement this guidance through rulemaking as soon as possible after publication by EPA.

Comment No. 3 - Questions whether the issue of assurance of the funding of decommissioning should be treated in the GEIS. (24, 30)

Discussion

As indicated in Section 1.1 of the Draft GEIS, the purpose of the GEIS is to assist the NRC in developing new policies and in promulgating regulations with respect to decommissioning of licensed nuclear facilities. In Section 15 of the GEIS, policy matters recommended for inclusion in proposed regulations are indicated, one of which is assurance of funding for decommissioning. As is stated in Section 15.1.3, providing reasonable assurance of availability of funds ensures that decommissioning can be accomplished in a safe and timely manner and that lack of funds does not result in delays in decommissioning that may cause potential public health and safety problems. Hence, the issue of financial assurance is, in this instance, appropriate to treat in this GEIS.

Comment No. 4 - Raises the question that the GEIS should include discussion of rulemaking on issues related to decommissioning, as well as more detailed discussion on the need for decommissioning regulations and their scheduled preparation. (23, 38)

Discussion

The GEIS discusses principally those issues related to decommissioning that are the subject of the regulations being amended. These include decommissioning alternatives, planning, financial assurance, and environmental review requirements. In addition, the GEIS discusses related areas, including waste management, safeguards and socioeconomic effects. The need for amended regulations is discussed in detail in Section 15 of the FGEIS. Pertinent regulations related to decommissioning are discussed in Sections 2 and 15 of the FGEIS.

A.2 Questions Related to Planning for Decommissioning

A.2.1 Initial Plans

Comment No. 1 - Some commenters question the usefulness of initial plans, specifically whether they have any use for facilities which would not be decommissioned for several years, and indicating that therefore they should not be too rigid and should allow for change (2, 7, 11, 14, 23, 28, 31, 34, 35), while other commenters raise the question that initial plans should be detailed, especially in the area of cost estimates. (32, 40)

Discussion

The terminology of a specific requirement for submission of "initial plans" has been dropped from use. Those provisions necessary to be addressed in planning for decommissioning early in facility life have been retained. These are financial assurance and facilitation. In the area of financial assurance, applicants and licensees need to indicate the provisions for providing reasonable assurance of the availability of funds for decommissioning. These provisions include the method of funding and the amount of funds to be set aside, as well as provisions for updating periodically over facility life. Specific criteria for the various types of facilities are different and are contained in the amended regulations. In the case of facilitation, the aspect of facilitation covered in the rule is recordkeeping. Licensees are to retain records important to decommissioning. However, submittal of information is not necessary. Other aspects of facilitation are not contained in the rule but are expected to be addressed in accordance with existing regulations and with regulatory guidance related to facilitation being considered.

With regard to the commenters requesting detailed initial plans, the requirements in the final regulations are very specific regarding funding methods, funding amounts, and recordkeeping requirements. In addition to the specific requirements early in facility life, the rule contains update provisions. Specifically, reactor licensees must submit preliminary plans containing detailed provisions for decommissioning five years prior to expected end of operations to take into account then current conditions related to decommissioning, as for example, waste disposal conditions. With the specific requirements for planning early in facility life indicated above and preliminary plans 5 years prior to end of operations, it is expected that decommissioning can be carried out in a manner which protects public health and safety.

Comment No. 3 - Raises the question that the initial plan should not be required because it could delay licensing cases. (2, 7, 10)

Discussion

As discussed above, initial decommissioning planning consists of financial assurance provisions and facilitation requirements, specifically recordkeeping for decommissioning. With regard to recordkeeping, licensees would be required to maintain but not submit records important to decommissioning. With regard to financial assurance, applicants and licensees would be required to submit provisions for funding as a reporting requirement in accordance with specific provisions contained in the rule. Further details in effect on pending licenses is contained in NUREG-1221, Section D.4.1.2.

Comment No. 4 - Raises the question how the matter of initial plans should be applied to existing plants. (3, 40)

Discussion

The primary purpose of financial assurance and recordkeeping requirements which make up the preliminary (or initial) planning part of the amended regulations is to provide information to establish adequate financial assurance provisions and to include consideration of facilitating decommissioning. As such, the need for these requirements are as necessary for operating plants as for new plants. As discussed in Section A.1.2 implementation procedures which are reasonable for decommissioning planning are contained in the amended regulations.

A.2.2 Updating of Plans

Comment No. 1 - Raises the question that the periodic updating of the initial plans should not be more frequent than once per five years and should not be the occasion for public hearings. (7)

Discussion

As discussed in the replies to the previous commenter, the initial requirements are reporting ones and do not require explicit periodic update by the licensee. Since they are entirely prescriptive, they do not offer occasion for public hearings. Moreover, the rule automatically adjusts the reactor decommissioning costs requirements annually.

A.2.3 Final Plans

Comment No. 1 - Raises the question of the contents of the final plan. (7)

Discussion

Final decommissioning plans would be submitted at the time of written notification that the licensee desires to terminate the license and would contain sufficient detail to permit an NRC determination that decommissioning can be accomplished safely. The content of the decommissioning plan is discussed in Section 15.1.2.2 of this GEIS.

A.3 Questions Related to Decommissioning Alternatives and to the Definition of Decommissioning

A.3.1 Conversion of Facilities to Other Uses

Comment No. 1 - Raises the question that the GEIS should consider conversion of facilities to nuclear or non-nuclear uses, or the reuse or refurbishment of the existing facility. (2, 5, 7, 23, 34, 37)

Discussion

As indicated in Section 2.4 of the GEIS, conversion to a new or modified use, or refurbishment and reuse of a facility, is not considered in detail in the GEIS. This is because conversion, itself, is not considered to be a decommissioning alternative, whether the new use involves radioactivity or not, according to the definition of decommissioning as presented in GEIS Section 2.3. If the intended new use involved radioactive material and thus was under NRC licensing authority, an application for license renewal or amendment or for a new license would be submitted and reviewed according to appropriate existing regulations. If the intended new use does not involve radioactive materials, i.e., unrestricted public use, and does not come under NRC licensing authority, then such application for a new use would be reviewed as a request for decommissioning and termination of license. In this case, the new use is not important except as it affects the decommissioning alternative chosen. For these reasons, conversion to a new or modified facility is not considered further in this GEIS.

Comment No. 2 - Questions whether the conversion of a facility to a low-level disposal site should be considered. (35)

Discussion

In general, the GEIS does not treat this issue for the same reasons as discussed in the response to Comment No. 1 above. With regard to the specific question of whether a nuclear reactor site could be converted to a low-level waste disposal site, this would involve licensing questions outside the scope of this GEIS. These questions would include the problem of evaluating whether the reactor site was environmentally suitable as a low-level disposal site.

A.3.2 Use of a "No Action" Alternative

Comment No. 1 - Questions whether there should be more detail on the "No Action" Alternative in the GEIS. (23, 30)

Discussion

As discussed in Section 2.4.1 of the GEIS, "No Action" is not considered viable for any facility discussed in this GEIS, and hence it is not considered in any detail. The reasoning for this is discussed in Section 2.4.1.

A.3.3 Initiation of Decommissioning

Comment No.1 - Questions whether the GEIS should discuss NRC authority to require the initiation of decommissioning and identify NRC criteria under which decommissioning will be required. (37)

Discussion

The question of NRC's authority to require the initiation of decommissioning is outside the scope of this GEIS. The purpose of the GEIS is to assist the NRC in developing regulations which will ensure that decommissioning is properly planned for and that, once begun, that decommissioning is carried out in such manner as to protect the health and safety of the public.

The rule amendments would require decommissioning plans for production and utilization facilities and ISFSIs to be submitted within two years following permanent cessation of operation or one year prior to operating license expiration. The decision as to whether a shutdown will be permanent is, of course, the licensee's. This provision does not limit how long a licensee may have a facility shut down under his operating license, but means only that when a facility is permanently removed from operational status, plans need to be made as to how the ultimate termination of license will be attained. Upon approval of the plans, the license will be modified to reflect the approved decommissioning alternative authorizing continued possession until the approved alternative has been carried out.

A.3.4 Decommissioning Alternatives

Comment No. 1 - Raises the question that, in general, any regulations on alternatives would have to be flexible, taking into account site-specific concerns; and in fact, alternatives should not be covered by a rule. (11, 23, 35)

Discussion

As discussed in the Overview section of the GEIS, it is the responsibility of the NRC, in protecting the public health and safety, to ensure that after a nuclear facility permanently ceases operation the facility is decommissioned in a timely manner consistent with the particular nature of a specific facility. Hence, general requirements regarding decommissioning alternatives must be included in decommissioning regulations. It is NRC's intention that proposed decommissioning rules provide sufficient flexibility to take into account individual situations while still maintaining consistency in the overall criteria and protecting public health and safety. Specifically, this approach can be seen in Section 15.1.1 of the GEIS which discusses the bases upon which different decommissioning alternatives could be used.

Comment No. 2 - Some commenters indicated that DECON (immediate dismantlement) should be the preferred alternative, and that if SAFSTOR is used, in no case should it be longer than 30 years especially for fuel reprocessing plants. (4, 31, 32, 36, 37) Other commenters indicated that the GEIS preference for DECON needs to be better justified; and that specifically there are health and safety implications for DECON, and that during DECON there should be delay time allowed for decay. (8, 23, 34) Other commenters indicated that there is insufficient justification of the problems indicated in the GEIS with delaying decommissioning. (2, 11, 23, 35) One commenter questions whether SAFSTOR shouldn't be allowed, at least in the case in which an owner maintains control of the site (8), and one questions why SAFSTOR is not allowed for greater than 30 years, especially since there could be technological improvements in the future which could further reduce the dose beyond 30 years. (11)

Discussion

The advantages and disadvantages of DECON and SAFSTOR for the various types of facilities discussed in this GEIS are discussed in detail in Sections 2.4 and 15.1.1 of the GEIS as well as in the specific sections for each facility (Sections 4 through 14 of the GEIS). Based on the analysis in those sections, Section 15.1.1 concludes that DECON or 30 to 50 years SAFSTOR are reasonable options for decommissioning a light water power reactor. Delay beyond that time would have to be justified based on unavailability of waste disposal capacity or site specific factors affecting safety such as presence of other licensed facilities on the site. Section 15.1.1 also concludes that for research and test reactors and independent spent fuel storage facilites, DECON is the most reasonable option although SAFSTOR could be justified in some cases. For fuel cycle and non-fuel-cycle facilities associated with licenses under 10 CFR Parts 30, 40, and 70, Section 15.1.1 indicates that DECON is the most reasonable option and although SAFSTOR is possible for short-lived materials, any extended delay would rarely be justifiable. More detail on areas of DECON and SAFSTOR is contained in NUREG-1221, Section B.4.

Comment No. 7 - Questions whether there should be special considerations for allowing SAFSTOR for ore processing facilities. (15)

Discussion

In the case of tailings piles, SAFSTOR may be justifiable until provision for removal of tailings, if necessary, can be accomplished. At the present time, tailings disposal would be on a specific case basis and could possibly be accommodated at phosphate or mill tailings piles that would ultimately require stabilization.

Comment No. 8 - Expresses the opinion that use of ENTOMB at power reactors should be acceptable, especially in light of cost concerns and the ability to store wastes in the entombed structure. (11, 23, 25, 30, 35)

Discussion

Sections 4.3.3 and 5.3.3 of the GEIS discuss the advantages and disadvantages of the ENTOMB alternative, and Sections 4.5 and 5.5 compare the ENTOMB alternative with the other decommissioning alternatives. These discussions are based to a large extent on information and data developed on ENTOMB by Battelle PNL for the NRC. In addition, Section 2.4 and Section 15.1.1 analyze the ENTOMB alternative. The GEIS sections indicate that ENTOMB, with the internals entombed, does not appear to be a viable alternative due to the presence of the long-lived nuclides Ni^{59} and Nb^{95} which would be present for thousands of years. If a facility were entombed with the internals removed, it may be possible to release the site for unrestricted use at some time within the order of a hundred years. However, one of the difficulties with ENTOMB for any complex structure such as a reactor is that the radioactive materials remaining in the entombed structure would need to be characterized well enough to be sure that they will have decayed to acceptable levels at the end of the surveillance period. Some method would have to be provided to demonstrate that the entombed radioactivity will decay to levels permitting unrestricted use which would be difficult. The ENTOMB alternative appears to be less desirable than either DECON or SAFSTOR based on consideration of the fact that ENTOMB results in higher radiation exposure and higher initial costs than 30-year SAFSTOR, that the overall cost of ENTOMB over the entombment period is approximately the same as DECON, and the fact that regulatory uncertainty after the long entombment period might result in additional costly decommissioning activity in order to release the facility for unrestricted use. More detail in this area is contained in NUREG-1221, Section B.5.

Comment No. 9 - Raises the question that health and safety differences between alternatives are not great and that costs and alternative uses of the facility should be considered, especially those uses which do not require full decommissioning (as DOE has done with some of its facilities). (34)

Discussion

See discussion of answer to item A.3.1 "Conversion of Facilities to Other Uses", comment 1.

Comment No. 10 - Points out that during SAFSTOR or ENTOMB only a very small portion of the land area originally covered by plant buildings would need to be restricted. (34)

Discussion

Provided that NRC licensing conditions were suitably modified to redefine the radioactive constituents of the facility requiring restricted use categorization, only the small portion of land originally covered by the plant buildings could be controlled and the rest be classified as unrestricted.

Comment No. 11 - Questions why the NRC has indicated a 100 year period on institutional controls for radioactivity confinement. (16)

Discussion

Although the DGEIS indicated a 100-year period for institutional controls of radioactive confinement, based on an old EPA draft policy, the FEIS has removed this comment and replaced it with a more general recommendation that institutional control reliance could be reasonable for the order of 100 years. This is also consistent with the section on institutional controls in 10 CFR 61 concerning low-level waste burial grounds.

Comment No. 12 - Some commenters question the definition of decommissioning which requires that the facility be returned to unrestricted use (11, 12, 16, 23, 30, 34, 35). One commenter agrees with the requirements that the facility be released for unrestricted use, but raises the question that more detail be given as to what facilities be released. (36)

Discussion

The definition of decommissioning as expressed in the GEIS provides a description of the process in a regulatory framework. Specifically, it is the process of removing a facility safely from service and reducing residual radioactivity to a level which permits release of the facility for unrestricted use and termination of the license. This definition expresses the complete process of decommissioning and puts it into the context of reaching a safe point.

It is the Commission's belief that there is nothing in the definition which would inhibit future use of the site once the license is terminated. Unrestricted use refers to the fact that from a radiological standpoint, no hazard exists at the site, the license can be terminated, and the site can be considered an unrestricted area. This definition is consistent with the definition of an unrestricted area as it exists in 10 CFR 20.3 as being "any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials and any area used for residential quarters." The specific future use of the site after the license is terminated is outside the scope of the GEIS. With regard to reuse of the site for nuclear purposes, there is nothing in this GEIS preventing such reuse. As indicated above, reuse of the nuclear facility for other nuclear purposes is not considered decommissioning. Therefore, a licensee would not be required to submit a decommissioning plan or apply for termination of license.

The rule also does not limit the use of alternative decommissioning methods which delay the completion of decommissioning thereby not releasing the site for unrestricted use during a period of radiological decay as long as the methods provide reasonable assurance of protection of public health and safety and there is a benefit in the use of the delay. The definition of decommissioning as well as the definitions of the alternatives contained in Sections 2.4 and 15.1.1 of this GEIS indicate that, if permanent cessation of nuclear activity occurs at the facility, the licensee is to propose to NRC the method that it intends to use in decommissioning the facility in a manner ultimately leading to the return of the site to an "unrestricted area" according to the definition of 10 CFR 20.3 and the termination of the facility license.

A.4 Questions Related to Acceptable Residual Radioactivity Levels at Decommissioned Facilities

A.4.1 General Requirements for Setting Residual Radioactivity Levels

Comment - Several commenters raise questions regarding setting of residual radioactivity levels. Some (1, 16, 31) said EPA has authority to set such criteria and NRC should, therefore, not precede EPA in setting such criteria, while some (23, 34, 40) said that regulations covering residual radioactivity are not needed now, especially in light of lack of high-level waste disposal criteria, and one (10) said residual limits should be set by the Radiation Protection Council. Several commenters made specific comments on the numerical value of the residual limit, how it should be chosen, and the dose pathway modeling which should be used one commenter indicated that residual limits for ore processing facilities should be set on a case-by-case basis. (2, 4, 7, 8, 9, 11, 15, 16, 23, 30, 32, 33, 34, 35, 37, 40).

Discussion

Comment Analysis and Response

The selection of an acceptable level is outside the scope of the rulemaking supported by this GEIS. Proposed Federal guidance is anticipated to be published by EPA. NRC is planning to implement the EPA guidance through rulemaking as soon as possible after it is issued. The Commission is participating in an EPA organized interagency working group which is developing Federal guidance on acceptable residual radioactivity for unrestricted use. Currently, criteria for residual contamination levels do exist and research and test reactors are being decommissioned using present guidance contained in Regulatory Guide 1.86 for surface contamination plus 5 μr/hr above background measured at 1 meter for direct radiation. As an example, NRC provided such criteria in letters to Stanford University, dated 3/17/81 and 4/21/82 providing "Radiation criteria for release of the dismantled Standard Research Reactor to unrestricted access."

A.4.2 Termination Survey

Comment No. 1 - Raises the question as to what nuclides will be considered in determining what are the principal nuclides for surveying, with concern that certain nuclides, which have longer half lives but may be initially insignificant, would be ignored. (37)

Discussion

The principal nuclides for surveying should be those that offer the best signature for detection (e.g., strong gamma emitters such as ^{60}Co for reactors). Generally those nuclides will also be the greatest dose contributors. Based on some reasonable nuclide spectrum analysis, it should be possible to demonstrate that removal of these signature nuclides to some acceptable level will result in adequate removal of non-signature nuclides with longer half-lives so that the dose contribution from those that remain will be acceptable. Of course careful spectrum analysis of a few representative cleaning areas should be performed to provide additional assurance that radioactive contamination has been properly performed.

Comment No. 2 - Questions whether there is measurement detection capability which is cost effective to measure concentrations corresponding to the acceptable residual radioactivity levels. (10, 16, 26)

Comment No. 3 - Questions whether the cost to decontaminate facilities to residual radioactivity levels corresponding to 10 mrem/year has been adequately addressed in the GEIS. (30, 34)

Discussion

See discussion in answer to Comment A.4.1.

A.5 Questions Related to Financial Assurance

A.5.1 Costs of Decommissioning

Comment 1 - Raises the question that the GEIS should indicate more clearly the uncertain nature of the cost estimates made. (23,30) Raises the question that the NRC should require that licensees obtain detailed cost estimates specific to their facilities and location rather than have them rely on Battelle PNL reports and their subsequent sensitivity analyses. (37)

Discussion

Sections 2.6 2 and 15.1.3 of the GEIS include discussions which recognize the uncertainties in the cost of decommissioning various nuclear facilities. Table 15.0-2, which is a summary of estimated costs for decommissioning nuclear facilities, indicates that the cost figures include a 25% contingency factor which can account for unforeseen events that might impede the conduct of the decommissioning work. In addition, the GEIS sections on LWRs (Sections 4 and 5) include sensitivity analyses which assess the variability in costs of decommissioning depending on various factors such as reactor size, plant design, contamination levels and waste disposal considerations. Also, it is indicated in Sections 2.6.2 and 15.1.3 of the GEIS that the funding levels will require updating over the life of a facility to assure that adequate funds are available for decommissioning.

It is not the intention of the GEIS to indicate that when cost estimates are submitted, NRC will accept cost estimates based solely on the Battelle PNL reports. However, due to limited experience in decommissioning, the Battelle PNL reports are useful for preliminary cost estimating. In using these reports to make cost estimates, a licensee must make suitable adjustments to account for facility differences and to make periodic revisions to his cost estimates.

More detail in this area is found in NUREG-1221, Sections D.1.1 and D.2.1.

Comment 2 - Raises the question that since costs are given in 1978 dollars, how would escalation affect costs. (3)

Comment 3 - Raises the question that the GEIS has not clearly presented the type of cost being listed in tables, namely whether they are discounted or undiscounted, so as to be able to properly compare costs of alternative plans which would take place over different time frames. (9)

Discussion

The costs in the final GEIS are given in 1986 dollars and account for the effects of escalation since 1978. Costs are given in present value dollars with the intention that decommissioning funds will be set aside in such manner that the principal plus accumulated interest, plus adjustments as necessary, will cover the effects of inflation on decommissioning costs and that decommissioning alternatives can all be directly compared.

Comment 4 - Questions where in references 1 and 3, cited on page 0-7 and listed on page 0-46 of the draft GEIS, that there is a discussion of the sensitivity of the cost of decommissioning to the dose level from residual radioactivity. (38)

Discussion

In Section 9.1.1.2 of NUREG/CR-0130 there is a discussion which indicates that the cost of decontamination of surfaces as estimated in that report is essentially independent of the level to which it must be decontaminated as long as that level is in the range of 10-25 mrem/yr to an exposed individual. Section 6.4 of NUREG/CR-0278 indicates that the report considers decommissioning activities necessary to release the facility for unrestricted use for both 10 and 25 mrem/year values. In the cost analysis of decommissioning in NUREG/CR-0278, only one set of cost estimates is presented since the report assumes that the values are essentially the same whether the acceptable residual level is 10 or 25 mrem/year.

In addition to those discussions, reference 1 of this section presents additional discussion of the basis for the statement that a difference in the acceptable residual radioactivity level between 10 and 25 mrem/year would have relatively small impact on the total decommissioning cost. (For additional discussion, see response to comment 3 in Section A.7.2.)

Comment 5 - Raises the question that the cost of decommissioning should include the cost of having the decommissioning effort performed by a contractor. (33)

Discussion

Sections 4.3.4 and 5.3.4 of the GEIS have been revised to include the impact on decommissioning costs (included in References 2 and 3) of having contractors perform the bulk of the decommission effort at reactors while the licensee retains certain overview and control functions. These references indicate that use of such contractors is likely for these large facilities.

For material facilities, the cost estimates do not specifically include the assumed use of contractor costs because amounts listed are considered reasonable in providing adequate funds so that a facility does not become a concern to public health and safety. The additional expense associated with requiring all material licensees to set aside in their funding method the added costs of assuming use of a contractor is not justified compared to the small number of licensees expected to have to use contractors. The increased cost of use of a contractor is not expected to be as large as suggested by the commenter.

Comment 6 - Raises the question that the GEIS should provide better detail of costs for certain material facilities where the survey costs may be significant. (38)

Discussion

Survey costs for five typical material facilities are presented in NUREG/CR-2241, which presents estimated survey costs for various types of nuclear facilities. The costs of the termination surveys for the material facilities considered can be compared to the overall costs of decommissioning these facilities which are presented in NUREG/CR-1754. In general, for these material facilities, the cost of the terminal survey is estimated to be approximately 5% of the overall cost of decommissioning assuming an acceptable residual radioactivity level in the range of 10 to 25 mrem/year to an individual.

For material facilities which require little or no decontamination effort, either because the source of radioactivity is sealed, or short-lived, or there has been no spread of contamination, it is intended that the survey effort will be minimal and of low cost.

Comment 7 - Questioned the accuracy of the cost estimates in the GEIS stating that they are too low, especially in light of the high cost of the operational decontamination at Dresden 1. (14)

Discussion

The cost information contained in the GEIS is a summary of costs developed in a series of reports prepared by Battelle-PNL on the technology, safety, and costs of decommissioning nuclear facilities. The purpose of these reports has been to develop a data base on decommissioning nuclear facilities to support an NRC reevaluation of its decommissioning policy. The PNL reports are detailed engineering evaluations of the activities involved in decommissioning nuclear facilities. The reports consider: (1) the detailed design and layout of the reference facility; (2) estimated conditions in the facility at the time of shutdown (just prior to decommissioning) including estimates of radionuclide inventory and radiation dose rates; (3) techniques for decontamination and dismantling which are current and proven; and (4) radiation protection requirement for workers and the public. Based on these considerations, the PNL reports develop detailed work plans and time schedules to accomplish decommissioning, including those for planning and preparation, decontamination, and component disassembly and transport. In making costs estimates of decommissioning, the PNL reports include such matters as work scheduling estimates, staffing requirements, specialty contractors, essential systems, radioactive disposal, and supplies.

Although it may be difficult to make comparisons between different cost estimates for different facilities because of site-specific considerations, it can be said that the PNL estimates represent reasonable approximation of the range of decommissioning costs, in particular because they use engineering assumptions and are based on decommissioning experiences. Other estimates, made independent from PNL and made using engineering assumptions, are in the same general cost range as PNL. Other estimates may be higher but careful review of the assumptions used should be made such as whether they use engineering assumptions or only extrapolations, whether they are in current dollars or future year dollars, and whether they include they cost of demolition and site restoration in the cost estimate. The PNL costs presented in this GEIS are in 1986 dollars and do not include the costs of demolition of nonradioactive structures and site restoration after termination of the NRC license.

More detail on the basis of the PNL studies and comparison with other estimates is contained in NUREG-1221, Section D.1.1.

Specifically, with regard to cost estimates made for the operational decontamination of Dresden 1, it is incorrect to compare the cost of decommissioning a plant to the cost of decontaminating an operating plant with the intention of returning it to service. Specifically, in the case of the operating plant it is necessary to do extensive testing and analysis to check material compatibility with decontamination solutions for eventual restart of the reactor. It is also necessary to run the decontamination process under very controlled conditions so as not to damage pressure boundary material. In addition, there will be additional system flushings necessary to ensure that the system is free of decontamination solutions before it is restarted. These additional system flushings can generate large volumes of additional radioactive waste which must be processed, packaged, and disposed of. These additional activities, which can be costly, are not necessary for a decommissioning in which the intent is to dismantle the plant and material compatibility is not as large a concern.

In addition, the Dresden 1 facility is an atypical situation. The Dresden 1 project was a research and development study for the purpose of demonstrating the feasibility of decontaminating plant systems to reduce occupational exposure prior to a plant resuming further operations. When returning a plant to field service, great care has to be taken to ensure that the decontamination solutions and procedures used do not adversely affect the plant's systems. Therefore the procedure used at Dresden was relatively costly since it was highly controlled as a research project. Conversely, decontamination solely for the purpose of reducing the worker dose prior to the initiation of decommissioning would not require the same level of system protection since the systems would never be intended for further use. The system at Dresden consisted of a much larger, more complex set of systems than the portable systems employed today for primary system decontaminations by several nuclear service companies. The costs of a single primary system decontamination is estimated by the service companies to be in the range of $1 to $3 million, depending upon site-specific circumstances. The system decontamination described in NUREG/CR-0130, including waste treatment but excluding waste disposal, was estimated to cost about $484,000 in 1978 dollars. When escalated to 1984 dollars, that cost becomes $1.07 million, in reasonable agreement with the prices currently quoted by nuclear service companies.

Comment 8 - Questioned the higher cost of decommissioning BWRs vs. PWRs as given in the GEIS, stating that the higher BWR costs are based on more restrictive assumptions regarding allowable occupational dose thus resulting in higher costs, and that higher costs for special equipment for BWRs are estimated. (6)

Discussion

The PNL studies for PWRs and BWRs have been updated and a summary of the results is contained in Sections 4 and 5 of this GEIS. In the updating, the assumptions regarding allowable occupational dose have been put on a common basis thus allowing better comparison of results.

Comment 9 - Raises the question that the GEIS should contain more detail on the matter of unforeseen expenses should there be cost overruns at low-level waste burial sites due to engineering and/or management control problems. (36)

Discussion

Sections 4 and 5 of the GEIS have been revised to include an evaluation of the technology, safety, and costs involved if it is necessary to store wastes onsite past the expiration of a facility operating license due to problems at disposal sites.

Costs of waste disposal are included as part of the decommissioning costs in Table 15.0-2. These costs are based on data developed in the Battelle PNL reports. The reports develop waste disposal costs by determining the volume of waste which must be buried, the curie content of the waste, and the costs of burial. The costs include a 25% contingency factor to account for unforeseen difficulties in carrying out the activities.

Specific details on problems at low level burial sites which may cause burial costs to increase in the future were beyond the scope of the original Battelle

PNL reports. It is intended that future revisions of these reports will consider updated considerations of burial site costs.

As discussed in Section 15.1.2.1, licensees will be required to submit 5 years prior to the projected end of operation up-to-date cost estimate on which to base financial assurance. In particular, this estimate would be based on a current estimate of major factors that could affect decommissioning costs, as for example, then-current problems at low-level waste burial facilities. This requirement is intended to ensure that the licensees consider relevant up-to-date information which could be important to adequate planning and funding for decommissioning well before decommissioning actually begins.

A.5.2 NRC Authority in the Area of Financial Assurance

Comment 1 - Questioned the authority of the NRC to write regulations in the financial assurance area, and specifically to allow certain funding methods, while precluding others. (2, 16, 24, 34, 35)

Discussion

The Commission's statutory mandate to protect the radiological health and safety of the public and promote the common defense and security stems principally from the Atomic Energy Act and Energy Reorganization Act. In carrying out its licensing and related regulatory responsibilities under these acts, the NRC has determined that there is a significant radiation hazard associated with nondecommissioned nuclear facilities and that the public health and safety can best be protected by promulgating a rule requiring reasonable assurance that at the time of termination of operations adequate funds are available so that decommissioning can be carried out in a safe and timely manner and that lack of funds does not result in delays that may cause potential health and safety problems. Although these acts do not permit the NRC to regulate rates or to interfere with the decisions of State or Federal agencies respecting the economics of nuclear power, they do authorize the NRC to take whatever regulatory actions may be necessary to protect the public health and safety, including the promulgation of rules prescribing allowable funding methods for meeting decommissioning costs.

More detail on this area is contained in NUREG-1221, Section D.8.1 and D.8.3.

Because of the diversity of NRC licensees and facility types, as discussed in Sections 2.6.2 and 15.1.3 of the GEIS, the NRC will allow latitude in implementation of funding methods to provide reasonable assurance of funding.

Comment 2 - Questioned the authority of NRC to require sureties, stating that Congress granted that authority only for the regulation of uranium mills in Section 203 of the Uranium Mill Tailings Radiation Control Act of 1978. (16)

Discussion

As discussed in Comment 1 of Section A.5.2, NRC has authority to require reasonable assurance of the availability of funds to decommission a facility based on its responsibility as stated in the Atomic Energy Act to protect the health and safety of the public. NRC has used its authority not only to require sureties for the decommissioning of uranium mills, but has used its authority under the Atomic Energy Act to require sureties to provide assurance of funds for the closure and stabilization of low-level waste burial grounds in Section 61.62 of 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

A.5.3 The Level of Assurance Required

Comment 1 - Disagreed with the GEIS statement that a "high" level of financial assurance was necessary for decommissioning, and indicated that the NRC should require "reasonable" levels of financial assurance. (7, 23, 24, 35)

Discussion

The GEIS has been revised to indicate that the NRC will require that there be reasonable assurance that funds for decommissioning will be available when necessary.

A.5.4 Acceptable Funding Methods

A.5.4.1 Need for Flexibility in Funding Methods

Comment 1 - Raises the question that because of the different types of reactor licensees, that NRC requirements must be flexible, and that it would be better to have case-by-case evaluations based on the specific licensee situations and general guidelines. (12, 24, 27, 29)

Discussion

The staff agrees with this comment. As discussed in Sections 2.6 and 15.1.3 of this final GEIS, the NRC is allowing latitude in the use of funding methods, based on two criteria. The first and most important criterion from the Commission's standpoint is reasonable assurance that funds will be available in a timely manner for safe decommissioning. Based on this criterion, certain funding methods are deemed acceptable in the proposed rule for providing reasonable assurance of funds. Latitude for choosing among these methods is permitted by the amendments to take into account other issues which are normally outside NRC's jurisdiction including rate collection, ratepayer cost, taxation effects, whether a method is equitable to ratepayers, and other local concerns.

A.5.4.2 Commenter Opinions Regarding Funding Methods

Comment - Some commenters indicated support for use of prepayment and external funds as the only allowable funding methods (1, 5, 16, 27, 32, 36, 37, 38, 40). Other commenters indicate that there should be more flexibility in NRC rules and that internal reserves should also be allowed since there is a significant cost advantage to the internal reserve and that the internal reserve provides reasonable assurance of funds for decommissioning.

Discussion

A revised discussion of acceptability of funding methods in terms of providing reasonable assurance of funds for decommissioning is contained in Sections 2.6 and 15.1.3 of the Final GEIS. The NRC has considered the use of various funding methods, and in particular internal reserve, in several documents and has reviewed public comments on the proposed rule and the draft GEIS. Based on these documents and on the discussions presented in Section 2.6.2 and 15.1.3 of this GEIS, and presented in more detail in NUREG-1221, Sections D.3.2.1 and D.3.2.2, using a standard of providing reasonable assurance that sufficient funds are available for decommissioning, electric utility licensees may use an external reserve sinking fund without additional financial assurance mechanisms such as insurance or purities. As noted above, more detail in this area is contained in NUREG-1221, Section D.3.2.1 and D.3.2.2.

A.5.4.3 Procedural Questions on Funding

Comment 1 - Indicated that, because current financial provisions for decommissioning are inadequate, that collection of funds should begin promptly and that there should be more detail on requirements for existing plants in the GEIS. (9, 27)

Discussion

Revised Sections 2.6 and 15.1.3 contains additional discussion concerning financial assurance requirements for operating plants. Upon issuance of an effective rule on decommissioning, current licensees will indicate to the NRC their provisions for providing funds for decommissioning within two years after the issuance of the final rule. Additional discussion on how existing licensees should carry out these activities is contained in Section A.1.2 of this Appendix.

Comment 2 - Raised the question that the regulatory approach of the NRC has not been able to deal with sufficient specificity on financial matters. (1)

Discussion

Sections 2.6 and 15.1.3 indicates funding methods considered acceptable to the NRC in assuring availability of funds for decommissioning. Section 15.2 indicates the intent of the NRC to publish decommissioning regulations covering the issues presented in Section 15.1. These regulations will contain specific requirements on allowable funding methods and on setting funding levels.

Comment 3 - Raises the question of how NRC will work with the state PUC's in assuring availability of funds. (40)

Discussion

NRC has included in its amended regulations funding provisions considered acceptable in protecting public health and safety. This is similar to other health and safety matters contained in the Commission's regulations. State PUC's are responsible for setting a utility's rates so that all reasonable costs of serving the public are satisfied, including costs of adhering to NRC regulations concerning decommissioning. Provisions contained in the amended regulations are very specific and NRC does establish specific requirements for indicating to the PUC's how reasonable assurance will be provided that funds will be available for decommissioning. Specific financial and local issues, such as rate of fund collection, procedures for fund collection, cost to rate-payers, taxation effects, equitableness, accounting procedures, ratepayer versus stockholder considerations, and responsiveness to change, will not be addressed by NRC but will be left to state PUCs to determine. The final rule recognizes that funding for decommissioning of electric utilities is also subject to the regulation of State and Federal agencies (e.g., FERC and state PUCs) having jurisdiction over rates, and that the NRC requirements are in addition to, and not substitution for, other requirements, and are not intended to be used, by themselves, by other agencies to establish rates. Hence, NRC does not intend to become involved as part of the decommissioning rate regulation process. More detail in this area is contained in NUREG-1221, Section D.8.3.

A.5.4.4 Opposed to GEIS Funding Recommendations for Fuel Cycle and Non-Fuel-Cycle Facilities.

Comment 1 - Two commenters raised the question that financial requirements will impose a financial burden on non-fuel-cycle facilities engaged in radiopharmaceutical medical research and development and clinical laboratory facilities, and also on tantalum manufacturers placing them at a disadvantage to foreign competitors. (15, 31) Another commenter (16) raised the question that self-insurance should be allowed since there is no evidence that it is not suitable, and that certain licensees are at least as financially sound as bonding or insurance companies or banks. This commenter also raised the question that sureties should not be required because there is no evidence in the GEIS that any licensee has ever defaulted in carrying out pertinent decommissioning requirements, and because they may not be available to licensees, and that they are not necessary since the NRC would not issue or renew a license if a licensee were not prepared to carry out decommissioning.

Discussion

The types of funding methods discussed in this GEIS, and allowed for materials licensees in the amended regulations, are consistent with those contained in earlier NRC promulgated rules in 10 CFR Part 40, Appendix A, regarding requirements for funding the decommissioning of uranium mills and mill tailings, and in 10 CFR Part 61 regarding funding for closure of low-level-waste burial facilities. The Commission found in developing those requirements that self insurance for a private sector applicant or licensee would not be an acceptable form of surety. Even if a private sector applicant or licensee is currently adequately capitalized, a lack of funds at the time of decommissioning, which may not occur for several years in the future, can cause problems with complete decommissioning. Problems such as bankruptcy have arisen in recent years with NRC licensees and Agreement State materials licensees not having sufficient funds for decommissioning.

As part of the effort involved in preparation of the proposed rules, NRC prepared a Regulatory Analysis, which evaluated the benefits and costs associated with the requirements contained in the proposed rules. The Regulatory Analysis indicates that the large majority of NRC licensees are exempted from the specific requirements on demonstrating financial assurances, although they are nevertheless financially responsible for paying for decommissioning as well as carrying out decommissioning. Those exempted include those possessing smaller quantities of radioactive material than prescribed in the regulations, those using sealed materials and those using material with half life less than 120 days. In addition, for many of those remaining licensees who must demonstrate funding assurance, a certification of an amount and funding method as prescribed in the rule would be sufficient. For those remaining licensees who must submit a funding plan, the plan would only be required at the time of license renewal at which time it is much more efficient for the licensee and staff to implement as part of the overall renewal effort. The regulatory analysis evaluated the costs associated with submittal of these funding plans. Based on these costs and on the number of exempted licensees, the regulatory analysis concluded that the moderate increase in overall costs to the NRC and the industry is balanced by the important increase in the effectiveness of decommissioning activities that will assure that impacts on health, safety, and the environment are minor.

As an additional effort to minimize impacts while maintaining reasonable assurance that funds are available for decommissioning, the NRC has decided to modify the proposed rule to permit the use of parent company guarantee when accompanied by financial tests for licensees. This is consistent with NRC's Policy Guidance Regarding Parent Company and Licensee Guarantees for Uranium Recovery Licenses issued in December 1985.

This area is discussed in more detail in NUREG-1221, Section D.6.

Comment 5 - Raised the question that financial assurance provisions should not be extended to facilities currently undergoing decommissioning. (16)

Discussion

See response in Section A.1.2 of the Appendix.

A.5.5 Funding for Premature Decommissioning, for Reactors Including Post-Accident Decommissioning

Comment 1 - Disagrees with the GEIS discussion or finds insufficient detail on funding for premature decommissioning, in particular post-accident cleanup and decommissioning. (7, 12, 23, 24, 28, 29, 32, 35, 37, 38) Also raised the question of how funding will be available for non-accident premature decommissioning. (5, 7, 12, 23, 24, 28, 29, 32, 35, 37, 38)

Discussion

Revised Section 8 of the GEIS entitled "Decommissioning of Reactors Which Have Been Involved in Accidents," based on a Battelle-PNL report on post-accident cleanup and decommissioning, contains information on the technology, safety, and costs of prematurely decommissioning a reactor which has been involved in an accident.

The availability of funds for post-accident cleanup is related to financial assurance for decommissioning. The costs of post-accident cleanup can be substantially larger than the costs of decommissioning. Assurance of funds for post-accident cleanup activities is more properly covered by use of insurance. Post-accident cleanup activities are broader in scope than decommissioning, that is, they can lead ultimately to either reuse or decommissioning. Accordingly, the funding requirements for accident cleanup are not included in the GEIS or in these amended rules but are contained in 10 CFR 50.54(w) which requires that utility licensees for production and utilization facilities obtain insurance to cover decontamination and cleanup costs associated with onsite property damage resulting from an accident.

With regard to the funding of decommissioning activities which would occur prematurely either following an accident or if an accident did not occur, NRC has had several studies done to address this issue. These include NUREG-0584, NUREG/CR-1481, NUREG/CR-3899, NUREG/CR-3899 Supplement 1, and NUREG/CR-2370. These documents address the question of assurance provided by the various funding methods, including prepayment, external reserve, internal reserve, and insurance. In particular, as discussed in Section 2.6 of the EIS and in more detail in NUREG-1221, Section D.3.2.1.1, NUREG/CR-3899 notes that the market value of utilities, even those involved in the most extreme financial crises, is still far in excess of decommissioning costs and that the value of the assets of a utility both tangible and intangible are more than adequate to cover future projected decommissioning costs. These considerations must also be viewed within the context of the Commission requirements for onsite property damage insurance in 10 CFR 50.54(W), discussed above, the proceeds from which a utility could use to decontaminate its reactor after an accident. Although these insurance proceeds would not be used directly for decommissioning, they would go a long way toward reducing the risk of a utility being subject to a tremendous demand for funds after an accident. Because most utilities are now carrying insurance in excess of $1 billion and the Commission has implemented its proposed requirement in 10 CFR 50.54(w) for insurance at this level, a major threat to long term utility solvency will have been substantially reduced.

In addition to the factors discussed in Section 2.6 of the EIS and in more detail in NUREG-1221, Section D.3.2.1.1, the considerations in NUREG/CR-3899 and the presence of the accident insurance provided by 10 CFR 50.54(w) one needs to balance the benefit of the reasonable assurance criteria against the cost or practicality of assurance. Methods that could be used to handle premature decommissioning include prepayment of funds, external reserve, insurance, and sureties. However, prepayment of funds has been recognized by several studies as being significantly more costly than the other methods. Furthermore, in view of the unlikely nature of the events and the potential problems being considered, prepayment has a cost too high for the benefit that would be realized. External funding would not by itself provide additional assurance for premature shutdown. Earlier studies in NUREG-0584 found that surety bonds were not generally available in the amounts necessary for decommissioning power reactors. Use of insurance for nonaccident related decommissioning was found in an earlier study performed for the NRC, NUREG/CR-2370, to have potentially serious problems of insurability and moral hazard and is not currently available. (Moral hazard is a term used in the insurance industry to indicate a situation of lack of loss prevention or loss control because those insured have access to risk prevention.)

In light of the factors considered, including the assurance provided by the various methods, the unlikely nature of the various events and the cost and practicality of providing more absolute assurance by certain methods, it is concluded that the funding methods provided in the proposed rules are adequate.

More detail in this area is found in NUREG-1221, Section D.3.2.1 and D.3.2.2.

A.6 Questions Related to the Effect on Decommissioning of the Unavailability of Waste Disposal Capacity

Comment 1 - Some commenters raised the question that the NRC's decommissioning regulations must consider the effect that the unavailability of high-level waste and low-level waste disposal capacity will have on the capability to decommission a facility. Two commenters raised the question that there needs to be low-level waste and high-level waste disposal regulations before questions about decommissioning can be resolved. One commenter (15) questioned the ability to assess realistically the impact of decommissioning criteria that call for disposal of high volume, low-level radioactive sludges because there are no sites available now or in the foreseeable future to accept this waste. (15) (3, 11, 16, 23, 30, 34, 36)

Discussion

Disposal of decommissioning wastes is covered by existing regulations and is beyond the scope of the rulemaking action supported by this GEIS. Disposal of spent fuel will be via geologic repository pursuant to requirements set forth in NRC's regulation 10 CFR Part 60. In addition, storage of spent fuel in independent spent fuel storage installations is covered by 10 CFR Part 72. Disposal of low-level wastes is covered under NRC's regulation 10 CFR Part 61. These regulations are all in effect. Because low-level wastes cover a wide range in radionuclide types and activities, 10 CFR Part 61 includes a waste classification system that established three classes of waste generally suitable for near-surface disposal: Class A, Class B, and Class C. This classification system provides for successively stricter disposal requirements so that the potential risks from disposal of each class of waste are essentially equivalent to one another. In particular, the classification system limits to safe levels the concentrations of both short- and long-lived radionuclides of concern to low-level waste disposal. The radionuclides considered in the waste classification system of 10 CFR Part 61 include long-lived activation products, such as Ni-59 or Nb-94, as well as "intense emitters" such as Co-60.

Wastes exceeding Class C limits are considered to be not generally suitable for near-surface disposal, and those small quantities currently being generated are being safely stored pending development of disposal capacity. The recently enacted Low-Level Radioactive Waste Policy Amendments Act of 1985 (Pub. L. 99-240, approved January 15, 1986, 99 Stat. 1842) provides that disposal of wastes exceeding Class C concentrations is the responsibility of the Federal Government. The Act also requires a report by DOE to Congress with recommendations for safe disposal of these wastes.

As far as decommissioning wastes are concerned, technical studies coupled with practical experience from decommissioning of small reactor units indicate that wastes from future decommissionings of large power reactors will have very similar physical and radiological characteristics to those currently being generated from reactor operations. Two of the studies performed by NRC include NUREG/CR-0130, Addendum 3, and NUREG/CR-0672, Addendum 2, which specifically address classification of wastes from decommissioning large pressurized water reactor (PWR) and large boiling water reactor (BWR) nuclear power stations.

These studies indicate that the classification of low-level decommissioning wastes from power reactors will be roughly as follows:

Waste Class	PWR (Vol. %)	BWR (Vol. %)
A	98.0	97.5
B	1.2	2.0
C	0.1	0.3
Above C	0.7	0.2

As shown, the great majority of the waste volume from decommissioning will be classified as Class A waste. Only a small fraction of the wastes will exceed Class C limits.

Disposal capacity for Class A, Class B, and Class C wastes currently exists. Development of new disposal capacity under the State compacting process is covered under the Low-Level Radioactive Waste Policy Amendments Act referred to above. This Act provides for incentives for development of such capacity, as well as penalties for failure to develop such capacity. For wastes exceeding Class C concentrations, DOE has offered to accept such waste for storage pending development of disposal criteria and capacity. For spent fuel, a detailed schedule for development of monitored retrievable storage and geologic disposal capacity is provided in the Nuclear Waste Policy Act of 1982.

Licensees will have to assess the situation with regard to waste disposal as part of the decommissioning plan which they submit according to the requirements of the amended regulations. In addition, the rule amendments require that at or about five years prior to the projected end of operation, each reactor licensee submit a cost estimate for decommissioning based on an up-to-date assessment of the actions necessary for decommissioning. This requirement is intended to assure that consideration be given to relevant, up-to-date information which could be important to adequate planning and funding for decommissioning well before decommissioning actually begins. These considerations would likely include an assessment of the then current waste disposal conditions. If for any reason disposal capacity for decommissioning wastes were unavailable, there are provisions in Section 50.82 of the amended regulations to allow delay in completion of decommissioning which would permit temporary safe storage of decommissioning waste. In addition, Section 50.82 contains requirements to ensure that adequate funding is available for completion of delayed decommissioning.

Although the DECON decommissioning alternative assumes availability of capacity to dispose of waste, alternative methods of decommissioning are available including delay in completion of decommissioning (such as SAFSTOR) during which time there can be storage of wastes. Delay in decommissioning can result in a reduction of occupational dose and waste volume due to radioactive decay.

Comment 2 - Raises the question that the NRC should consider the decommissioning of low level waste storage facilities erected at reactor sites. (8)

Discussion

Battelle PNL, as part of development of the data base for this GEIS, prepared an evaluation of the technology, safety and cost of decommissioning a nuclear facility for the case in which waste must be stored at the site after expiration of the operating license. That evaluation also includes an evaluation of the decommissioning of the temporary low-level waste storage facilities. This evaluation showed the additional impact was not significant.

One commenter (15) questions the ability to assess realistically the impact of decommissioning criteria that call for disposal of high volume, low-level radioactive sludges because there are no sites available now or in the foreseeable future to accept this waste. (15)

Comment 3 - Raises the question that on-site, low-level waste disposal is the most likely and most reasonably available method for decommissioning. (16)

Discussion

As indicated in the response to Comment 1, decommissioning regulations will contain provisions for use of delayed decommissioning alternatives, such as SAFSTOR, for facilities which must store low level waste at the site past the expiration date of the facility operating license. However, it is assumed that this storage at the site will be temporary. Permanent conversion of sites to a low level waste burial facility is not considered a decommissioning alternative because, as is stated in Section 2.3 of the GEIS, decommissioning of a facility leads to unrestricted use. Conversion and use of a facility for a LLW disposal site after its operating life is over is outside the scope of the rulemaking supported by this GEIS and would have to be reviewed on a case by case basis by NRC.

Comment 4 - Disagreed with the statement made in Section 2.7 of the draft GEIS that the quantity of waste from operating reactors will considerably exceed that generated by facilities being decommissioned, although one commenter indicated agreement with the statement. (1, 35)

Discussion

The basis for the statement in Section 2.7 of the draft GEIS is that it has been estimated that an operating 1000 MWe reactor will generate approximately 1300 m^3/yr of low level waste. Thus for 100 reactors, the total waste volume generated would be approximately 130,000 m^3/yr. DECON of a reactor is estimated to generate less than 5000 m^3/yr over a 4 year period.

It is recognized in Section 2.7 in the GEIS that, for any one reactor, decommissioning will generate an appreciable fraction of the low level waste generated by a reactor over its lifetime. It is also recognized in the GEIS that there is a need for burial capacity of this low level radioactive waste.

Comment 5 - Questioned the validity of the comparison made in Section 0.4.4 of the GEIS of 17900 m^3 of waste volume generated to 1160 acres that the plant originally occupied.

Discussion

The comparison was between the 2 acres which would be used at a low level waste burial ground for the 17900 m^3 and the 1160 acres originally used as the site of the reference PWR. The comparison is valid because the operating nuclear facility with restricted use covering 1160 acres has been converted to 2 acres of waste disposal space following termination of license.

A.7 General Technical Questions About Decommissioning

A.7.1 Questions on the Information Base Developed for the GEIS

Comment 1 - Questions the adequacy of the information base developed for the GEIS, in particular the lack of completed reports on research and test reactors, multiple reactors, non-fuel-cycle facilities, UF_6 conversion plants, and post-accident decommissioning. (1, 5, 7, 16, 23, 30, 36, 38)

Discussion

The technical data base upon which the GEIS is based represents an extensive study of the decommissioning of nuclear fuel cycle and non-fuel-cycle facilities. Since the draft GEIS was issued, reports on the technology, safety and costs of decommissioning the following facilities have been completed: multiple reactors, non-fuel-cycle facilities, UF_6 conversion plants, research and test reactors, independent spent fuel storage installation and decommissioning of reactors and fuel cycle facilities involved in accidents. Reports that had already been completed at the time the draft GEIS was published include the technology, safety and costs of decommissioning the following facilities: pressurized water reactors, boiling water reactors, reprocessing plants, fuel fabrication plants, and mixed oxide fuel fabrication plants. Also reports on the technology and costs of termination surveys to verify that residual radioactivity levels meet acceptable levels have been completed.

Based on the above, it is the NRC's judgment that the development of the data base is sufficiently complete to develop the GEIS and subsequent rules. More details on this area are in NUREG-1221, Section D.1.1.

Comment 2 - Raises the question that the GEIS does not provide enough technical detail or historical detail to provide information on decontamination and decommissioning performance. (30)

Discussion

As stated in the GEIS, Section 1.1, the purpose of the GEIS is to assist NRC in promulgating revisions to regulations on decommissioning. As such, the GEIS presents a summary of the technical data base. The full technical data base including detailed information on decontamination and decommissioning techniques and experience is contained in over 20 volumes of reports prepared by Battelle-Pacific Northwest Laboratories. These reports are referenced through out the GEIS and should be used if detailed technical information is necessary to a user. These include large amounts of technical and historical detail on decontamination and decommissioning performance.

Comment 3 - Raises the question that waste volumes, and content, and risks have been underestimated in the GEIS. (1)

Discussion

The quantities and radioactivity of the wastes arising from decommissioning are developed in the Battelle-PNL reports through an analysis of the radionuclide inventory in the plant at the time of plant shutdown, the types and quantities of wastes that must be disposed of and the decontamination procedures that generate waste volumes. The pressurized water reactor and boiling water reactor reports also provide details concerning the sensitivity analysis of impact of differing plant conditions, including different amounts of contamination than those initially estimated and different reactor sizes.

This is based on the data base currently existing on decontamination and decommissioning and on estimated plant condition at the time of shutdown. Based on the detailed technical analysis completed, the waste volumes and risk associated with decommissioning are not considered to be underestimated. More detail on this area is found in NUREG-1221, Sections D.1.1 and H.1.

Comment 4 - Raises the question of why decommissioning of HTGRs is not considered in the GEIS. (35)

Discussion

The purpose of developing the technical data base is to provide support for development of a generic rule on decommissioning which can provide consistent licensing basis and remove the need for case-by-case licensing decisions. Since there is only one HTGR currently in commercial operation and none are currently planned to be built, there is no currently sufficient need to study, in a generic manner, the decommissioning of HTGRs. Review of the decommissioning for that facility can be undertaken on a case specific basis. Of course, the existing HTGR will be required to conform to general proposed rule requirements, namely financial assurance, planning, and decommissioning alternatives, although specific details will have to be considered for the plant.

Comment 5 - Questions the adequacy of the NRC analysis on the decommissioning of low level waste burial grounds and questions whether the NRC analysis of fuel reprocessing plants is based on realistic models. (32)

Discussion

Detailed evaluation the decommissioning of low level waste burial grounds is outside the scope of this GEIS. This evaluation is contained in NUREG-0782, Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste," September 1981, and in the proposed rule on "Licensing Requirements for Land Disposal of Radioactive Waste," 46 FR 38081, July 24, 1981.

The Battelle-PNL study on the technology, safety and costs of decommissioning a fuel reprocessing plant is based on the Barnwell Nuclear Fuel Plant, located in Barnwell, South Carolina. Although the Barnwell Plant has never operated as a fuel reprocessing plant (FRP), its design is considered to have characteristics typical of those present in any future FRP. In addition, because the existing portions of the Barnwell plant do not include facilities for high-level liquid waste solidification (which any future FRPs would contain) the Battelle-PNL study included a conceptual facility of this type added on to the Barnwell plant and analyzed its decommissioning.

Although the Nuclear Fuel Services (NFS) plant in West Valley, New York, is the only commercial reprocessing plant that has operated in the United States (although it is not currently operating) it is not used as the reference plant. The NFS situation is not directly translatable to the present or projected nuclear power industry because a national policy (10 CFR Part 50, Appendix F) requiring the solidification of high-level waste was not established until 1971, well after the plant began operation. Therefore, since NFS has its reprocessing high-level wastes stored in large underground tanks in slurry form, the costs of decommissioning this plant would be expected to be higher than that of any new FRPs if they were to be constructed and hence West Valley was not used as the reference plant.

At the present time no commercial spent fuel is being considered for reprocessing.

Comment 6 - Raises the question that the draft GEIS has not adequately handled the problems of decommissioning following an accident, specifically the costs, financial considerations and procedures. (7, 35, 37, 39)

Discussion

See revised GEIS Section 8 for a discussion of decommissioning of a reactor which has been involved in an accident.

A.7.2 Technical Details

Comment 1 - Raises the question that the NRC assumption that "good housekeeping" practices have been employed is not valid. (1)

Discussion

The full sentence quoted above from page 2-13 of the draft GEIS is "Most rooms should not be mildly contaminated with radioactivity in excess of levels which are acceptable for unrestricted facility use since it is assumed that good housekeeping and ALARA practices will be used during facility operations to control the spread of contamination." The context of this sentence is that most rooms will either be highly contaminated, thus requiring extensive decontamination efforts, or will have very low contamination levels because of the need to control occupational exposures during operations. These exposures during operations must be kept "as low as reasonably achievable" in accordance with 10 CFR 20.1 and with Regulatory Guide 8.8.

The draft GEIS, Section 2.5.3, goes on to state that, if necessary, decontamination of these mildly contaminated rooms during decommissioning can be accomplished at a low cost and with low expenditures of manpower.

Comment 2 - Questions how decommissioning will vary as a function of the year of design of the LWR and the effect of different levels and durations of plant operation. (3)

Discussion

The development of the technical data base on decommissioning included an analysis of the sensitivity of the technology, safety and cost of decommissioning to several different parameters considered to be potentially significant in their effect. These parameters included: (1) plant size (thus considering the level of plant operations, as well as the year of design of the reactor since older reactors are generally a small power level while newer reactors are larger); (2) the degree of radioactive contamination (thus considering the duration of plant operation since with longer lifetimes there could be greater contamination); (3) waste disposal charges; (4) contractual arrangements; and (5) for BWRs, different containment designs. The results of these sensitivity analyses are contained in Sections 4.3.4 and 5.3.4 of the GEIS. These sections point out that, while there were some differences in results, the conclusion of the sensitivity analyses is that the differing parameters do not substantially affect the original cost and dose conclusions.

Comment 3 - Disagrees with GEIS statement (made in the draft GEIS, Section 2.5.3) that decontamination costs for a facility are essentially independent of the level to which it must be decontaminated as long as it is within the range of 1-25 mrem/yr. (23, 30, 34, 38)

Discussion

The context of Section 2.5.3 of the draft GEIS is that cost-benefit considerations are involved in the evaluation of the extent of facility decontamination necessary to decommission the facility, i.e., to release it for unrestricted use. In estimating the costs of decommissioning, it is assumed that all neutron-activated material and all potentially contaminated piping and equipment is removed and disposed of as radioactive waste. The question of unrestricted release levels becomes important when the final cleanup of the structures is begun. In the PNL analyses costs of decommissioning were computed on the basis that in all areas anticipated to have contaminated concrete surfaces, two inches of concrete were removed and disposed of as radioactive material. These surfaces included such areas as the walls and floor behind stainless-steel-lined pools and the walls and floors of process areas. Where an eight-inch concrete block wall was involved, the analyses postulated removing the entire wall, not just the two-inch surface layers.

There will, in practice, be situations where contamination has penetrated more deeply than two inches. At the same time it should be recognized that most of the concrete surfaces will be contaminated to a depth of about one-half inch or less. Thus, the approach of evaluating the cost of removing and disposing of a two-inch layer is generally conservative and should adequately cover the instances where additional material must be removed locally to obtain a clean surface.

Even if additional concrete must be removed it will not have significant impact on the overall costs of decommissioning. The incremental cost of removing twice as much concrete in releasing the facility for unrestricted use has been estimated as adding approximately 2% to the cost of decommissioning. This is within the 25% contingency factor which is included in the cost estimates in Tables 4.3-1 and 5.3-1.

Based on the preceding discussion the cost of decommissioning the facility, i.e., reducing the contamination to unrestricted use levels, is essentially independent of the unrestricted use level, as long as that level is in the range of 1-25 mrem/year to an exposed individual.

Comment 4 - Comments that existing operational ALARA considerations are adequate, and comments that any NRC-proposed facilitation requirements should be justified on a rigorous cost-benefit basis. (10, 34)

Discussion

The studies performed as part of the policy reevaluation have shown that facilitation of decommissioning in the design of a facility or during its operation can be beneficial in reducing operational exposures and waste volumes requiring disposal at the time of decommissioning. In addition, facilitation can improve financial assurance by keeping actual costs of decommissioning in line with the estimated costs on which the levels of financial assurance are based. A specific requirement on facilitation was contained in the proposed rule (recordkeeping), the effects of operational procedures on decommissioning should be considered by licensees as part of their program to maintain radiation exposures and effluents "as low as reasonably achievable." The facilitation of decommissioning in the design of facilities can be considered under the general standard for issuance of license that equipment and facilities be adequate to protect the health and safety of the public contained in §§ 30.33(a)(2), 40.32(c), 50.40(a), 70.23(a)(3), and 72.31(a)(10). Suggestions for facilitation are presented in the PNL studies and in a preliminary study on facilitation of reactor decommissioning prepared for NRC.

In particular, experience has shown that an important aspect of facilitation during operations is the maintenance of adequate information on the design and current condition of the facility and site, so that decommissioning can be carefully planned and carried out. The amended rule does specifically require that records of relevant operational information helpful in facilitating decommissioning be kept by all reactor and materials licensees. Plans should be developed to collect, maintain, and recall records and archive files which include as-built and as-revised drawings and specifications and operational occurrences which could significantly affect decommissioning. The amended rule specifically allows the use of references to relevant information and locations in order to avoid unnecessary duplication of records kept for other purposes and also specifies that referencing of drawings need not include indexing of each individual relevant document. The intent of this requirement is to assure that all important information is kept until termination of license and that it be readily accessible when needed.

Comment 5 - Disagrees with the GEIS statement that the technology for decommissioning is well in hand, because technology has not been developed to remotely dismantle a reactor after 30 years, and because reusable decommissioning equipment and equipment which could further lower costs and occupational exposures has not been developed. (32)

Discussion

The context of the statement in GEIS Section 15.0, referred to in Comment 5 above, is that the technology for decommissioning nuclear facilities is well in hand and, while technical improvements in decommissioning techniques are to be expected, decommissioning at the present time can be performed safely and at reasonable cost.

Radiation dose to the public due to decommissioning activities should be very small and be primarily due to transportation of decommissioning waste to waste burial grounds. Radiation dose to decommissioning workers should be a small fraction of their exposure experienced over the operating lifetime of the facility and usually be well within the occupational exposure limits imposed by regulatory requirements. Decommissioning costs are reasonable and are, at least for the larger facilities such as reactors, a small fraction of the present worth commissioning costs (i.e., less than 10%). This statement is not meant to imply that there won't be technical improvements in the future and as decommissioning experience is obtained these improvements will be made, however as is stated decommissioning can be performed safety. Based on the statements in Section 15.0, regulations can be written containing requirements for decommissioning.

Comment 6 - Raises the question that the GEIS should contain more detail of the impact of wastes from decommissioning activities on waste disposal sites. (30)

Discussion

See Section A.6 of this Appendix. In addition the environmental impact associated with waste disposal sites is contained in the Final Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste."

Comment 7 - Raises the question that the GEIS should consider the impact that variations in residual radioactivity criteria would have on projected waste volumes. (30)

Discussion

As discussed in Section 2.5 of the Final GEIS the impact of differences in residual radioactivity limits, within a reasonable range, is not significant in terms of cost. Hence the impact on waste disposal is not expected to be significant.

A.7.3 Socioeconomic and Human Factors

Comment 1 - Questions whether the GEIS should contain more detail concerning the socioeconomic impacts of shutting the plant down and decommissioning it. (8, 40)

Discussion

As discussed in GEIS Sections 4.4, 5.4, and 7.4.3, the major socioeconomic impact occurs prior to decommissioning, namely at the time of the owner's decision to shutdown the nuclear facility, thus removing a source of employment and tax income for the community. Treatment of these effects is outside the scope of this GEIS. Decommissioning activities tend to mitigate the impact of job and tax income reduction for a period of time after shutdown, and hence those effects are not treated in detail in the GEIS.

Comment 2 - Questions why the GEIS does not consider "human error" in its analysis. (40)

Discussion

Because the reactor is not operating during decommissioning, the analysis contained the GEIS and the information base prepared by Battelle-PNL does not include the significant impacts which can result from human error at operating facilities.

Nevertheless, the GEIS and the information base reports do contain in their analysis several considerations of human error. For example, Tables 4.3-1 and 5.3-1 indicate that costs for decommissioning include a 25% contingency factor which can account for unforeseen events that might impede the conduct of the decommissioning work. The costs listed in the table also include scheduling and cost allowances for inefficiencies associated with working in radiation environments.

In addition, the GEIS includes (see for example, Tables 4.4-2 and 4.4-3) an analysis of the radiation dose impact to the public from accidents resulting from various causes, including human error. The GEIS found that even for the most severe accident that the doses were moderate (see for example, Section 4.4). The information base developed by Battelle-PNL also includes an analysis of injuries to workers resulting in lost time from the job, and worker fatalities. This analysis was based on industrial type accidents during the decommissioning. It was found, for example, that for boiling water reactors that less than 10 lost-time injuries to workers would occur, and that essentially no fatalities due to industrial accidents would occur during the decommissioning or the transportation of decommissioning wastes.

In order to minimize human error, Section 15.1.2.2 recommends that quality assurance provisions during conduct of decommissioning be described in the decommissioning plan. This would involve describing the equipment and procedures requiring QA procedures during decommissioning. As another means of minimizing human error, Section 15.1.2.1 recommends that records of information important to a decommissioning be kept over the lifetime of the facility. These records would include records of spills and unusual occurrences involving spread of contamination in the facility and would also include as-built drawings and modifications of structures and equipment in high radiation areas. Maintenance and availability of such records at the time of decommissioning will assist plant staff in conducting work in radiation areas and minimize radiation exposure and human error.

Comment 3 - Questions why the GEIS does not mention the impact that the disposal of decommissioning waste will have on communities surrounding the waste burial grounds. (40)

Discussion

The GEIS includes an analysis of population exposure from truck transport of decommissioning waste to burial grounds. (See, for example, Tables 4.3-2 and 5.3-2). The evaluation of the impact of waste at the burial grounds is outside the scope of this GEIS, but analysis of the environmental impact of waste is included in the Final Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal or Radioactive Waste," November 1981.

A.7.4 Occupational Exposures

Comment 1 - One commenter (38) questions the basis of the GEIS statement that the occupational radiation dose resulting from DECON of boiling water reactors and fuel reprocessing plants is of marginal significance to health and safety while another agrees with GEIS statement that decommissioning of a reactor can be accomplished with reasonable occupational radiation exposure and virtually no public radiation exposure.

A.7.5 Non-Fuel-Cycle Facilities

Comment 1 - Raises the question that decommissioning considerations for non-fuel-cycle facilities should be different from those for fuel cycle facilities, because of the different nature of the facilities; and also that there should be separate consideration for difficult types of non-fuel-cycle facilities and that for some processing facilities, decommissioning considerations should be on a case-by-case basis. (15)

Discussion

The GEIS recognizes the unique nature of the different types of facilities by treating them in separate analyses and by analyzing the costs, waste disposal concerns, and decommissioning alternatives for the different types of facilities. Specifically revised Section 14 of the GEIS discusses the alternatives, cost, dose impacts, and waste disposal of the different major type of non-fuel-cycle facilities requiring significant decommissioning action, including sealed source manufacturers, radiochemical and radiopharmaceutical manufacturers, ore processors, and broad research and development facilities.

Despite the different and unique nature of the non-fuel-cycle facilities, the general NRC policy consideration outlined in Section 15 of the GEIS can apply in general to all facilities. These policy considerations include planning, financial assurance, and decommissioning alternatives. All facilities considered in this GEIS, and in subsequent rulemaking, which have a significant decommissioning effort, need to plan for decommissioning; need to establish a fund; need to consider which of the decommissioning alternatives is most appropriate and what the timing of that alternative should be; and need to have criteria for acceptable levels of residual radioactivity.

The GEIS recognizes the unique nature of the different facilities in several GEIS sections. Section 15.1.1 recognizes that different decommissioning alternatives may be more logical for certain facilities than others. Section 15.1.3 recognizes that because of the diversity of facility types, different funding methods may be acceptable.

Certainly in any decommissioning, including that for an ore processing facility, there will be case-by-case considerations but it is expected that these will fit into the general guidelines of these amended regulations. Regulatory guides under consideration will treat such considerations.

Comment 2 - Raises the question that the cost of decommissioning ore processing facilities is significantly underestimated and that the GEIS does not adequately treat the cost of transporting waste from ore processors to low level burial facilities.

Comment 3 - Raises the question that the GEIS has underestimated the complexity of decommissioning an ore processing facility and not provided sufficient basis for the statement that decommissioning of an ore processing plant has only minor adverse impact. (15)

Discussion

As stated in the GEIS, Chapter 14, the major problem with the ore processing facility decommissioning is the tailings pile disposal problem. The GEIS recognizes many options for handling tailings, such as possible disposal in a local landfill, depending on an acceptable residual level (p. 14-20), in place stabilization (p. 14-22), through to a removal option for which the major costs of transportation and burial for the example case is 33 million in 1986 dollars (p. 14-20). Thus the GEIS recognizes that decommissioning of an ore processing facility can, depending on circumstances at the time, be reasonably simple or very complex in terms of cost.

Appendix B: Comments Received on the
Draft Generic Environmental Impact Statement.

This Appendix contains copies of the original comment letters received. Background documents referred to by comments are not included but can be obtained from the Public Document Room (under Federal Register Notice Number 46 FR 11666 where the original versions of the letters are kept).

Table B-1 lists the source of the comment letters.

Table B-1

Comment Letters on the Draft GEIS

Docket No.	Commenter	Page
1	Marvin Lewis	B -4
2	San Diego Gas and Electric	B -7
3	Wisconsin Public Service Commission	B-10
4	Jay Gertz	B-12
8*	Tennessee Valley Authority	B-13
9	United States Environmental Protection Agency	B-19
10	Combustion Engineering	B-21
11	Detroit Edison Co.	B-23
12	Deloitte, Haskins and Sells	B-26
13	Klevorn, Dreyer and Dubois	B-33
14	Houston Light and Power Company	B-37
15	Baker and Hostetler	B-39
16	Kerr-McGee Corp.	B-47
17	Hesslin	B-67
18	Mallinckrodt, Inc.	B-72
19	Michigan Public Service Commission	B-73
20	Consolidated Edison Company	B-77
21	General Electric Company	B-80
22	Commonwealth Edison Company	B-83
23	Atomic Industrial Forum	B-87
24	Debevoise and Liberman	B-102
25	Duke Power Company	B-127
26	General Electric Co.-Nuclear Fuels and Services Divn.	B-129
27	Consumers Power Company	B-132
28	Public Service Electric and Company	B-134
29	Arizona Public Service Company	B-135
30	U.S. Department of Energy	B-139
31	Health Industry Manufacturers Assn.	B-150
32	Sierra Club Radioactive Waste Campaign	B-155

33	Texas Dept. of Health	B-160
34	Public Service of Indiana	B-163
35	Arkansas Power and Light Co.	B-173
36	Texas Dept. of Water Resources	B-185
37	California Energy Commission	B-195
38	New York State Dept. of Environmental Conservation	B-200
39	Ohio Citizens for Responsible Energy	B-209
40	J. A. Savage	B-210

*Comments from General Electric, Consolidated Edison, and Commonwealth Edison were inadvertently docketed twice as numbers 6, 20 and 5, and also as numbers 21, 7 and 22, respectively. Therefore, docket numbers 5, 6, and 7 are not listed here.

DOCKET NUMBER
PROPOSED RULE PR-30,40, 50, 70, +72
(46 FR 11666)

(1)

Marvin I. Lewis
6504 Bradford Terrace
Phila. PA 19149
3-6-81.

DOCKETED
USNRC
MAR 13 1981
Office of the Secretary
Docketing & Service
Branch

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Washington, D.C. 20555

Dear Sir;
Please accept the following letter as my comments on the Draft Generic Environmental Impact Statement on Decommissioning o Nuclear Facilities, Nureg 0586 January 1981.

My first Comment is that I had to call up the NRC because the due date for the end of comments on this NUREG was not readily found in the NUREG. I had to waste time on a telephone call to the NRC just to find out t hat the end of the comment period was March 23, 1981. It should have clearly stated on page ii what the expiration date for comments is.

2. This is a very extensive issue thatthis NUREG covers. It depends heavily upon an entire boxful of other NUREGS The NUREGS t hat t his NUREG 0586 depends upon are a series of NUREGS entitled "Technology, Safety and Costs of Decommissioning a Reference *****------." The ******---------- refer to various nuclear fuel facilities. This series, "T, S, and C of Decommissioning a Reference****---- is very flawed. Further, this series is not complete and the NUREG "T, S, and C of Decommissioning a reference llw Burial Ground" has only been delivered in this last week. "T, S, and C of Decommissioning a Reference Multireactor Power Station" still has not been issued.

Therefore Comments are being solicited on a NUREG 0568 which rests upon a series of NUREGS which are not completed nor issued. Further, that part of the series which has been issued is flawed in underestimating volume, Curie, and danger of the wastes. (Peter Skinner NY Law Dept at a Radwaste Planning Sessionfor State Officials put on by the NRC in Phila. PA)(Also see Resnikof in 'Not Man Apart ' newsletter, aseries on transportation of radwaste.)

3. This NUREG is internally flawed as well as resting upon flawed references. Inotherwords, statements in this NUREG, which do not depend upon a reference, are also incorrect. For instance on Page O-8,
"In any given year the quantity of this waste generated by decommissioning will be considerably less than that generated b by operating nuclear facilities."
Well, that statement may have been true in the past. The reason that the waste from decommissioning in the past was less ~~than~~ than generated by operating nuclear facilities was dependent upon several factors:
A. Nuclear power is a 'new ' technology and most plants had not reached their retirement age.
B. Nuclear facilities which were due to retirement for various reasons had their retirements deferred. (West Valley, Barnwell, Hanford, Alliquippa.)

3. C. There has only been one Class 9 accident to date. That was at TMI#2. It happened on March 29,1979 ard is continuing to this date and probably beyond. Drs Rasmussen, W.H.Jordan and the Advisory Committee on Reactor Safegaurds have all gone on record that we may expect a TMI#2 type accident every 4 to 5 years. (Dr Rasmussen on Phila radio in May following the TMI#2 accident. Dr Walter H. Jordan in his recent book with S. Glasstone on Nuclear Safety. ACRS in a statement by a member quoting a German Study.)

In light of the above information the statement, "In any given year the quantity of this waste generated by decommission ing is considerably less than that generated by operating nuclear facilities." is indefensible speculation.

4. Page O-8 "Assurance of this availability of (decommissioning) funds is necessary to ensure that a health and safty problwm does not result because of undue delay in performing the required decommissioning." That statement is one that I can agree with. However, that has not been the regulatory stance of the NRC. The regulatory stance of the NRC has been to deal without sufficient specificity on financial matters.
"Present regulatory guidnace is not specific enough on required particulars needed to deal properly with financial assurance consideration." Page O-8 Paragraph O.2.6.1. Nothing in this NUREG requires a change of regulatory stance to one of proper assurance of funds for decommissiong to protect the health and safety of the public. Without a change of regulatory stance which would require proper assurance of timely availability of decommissioning funds, this NUREG is worthless. Regulatory requirements for timely availabilty of decommissioning funds must be set in stone. Decommissioning funds must not be a matter of conjecture. ~~Thus~~ These funds must be wholely available at any time in a reactors lifetime. The accident at TMI#2 demonstrated that a reacter can need its decommissioning funds long before the scheduled date of retirement.

Availabilty of decommissioning funds is one of the most important points in decommissioning. This funding is grossly and inadequately handled in this NUREG for the reasons stated above.

5. Residual Radioactivity Levels for Release of a Facility to Unrestricted use.
Well, this is really up in the air. Epa was supposed to do this but hasn't yet. NRC has presented its views. Where , when, and who is going to make the decision. Meanwhile , this nureg was sent out to get comments when the most essential item in it is still in limbo. How can I comment on something that is not even there yet?

Take this Draft back until such time as hearings and public comment has been incorporated by EPA into a dose level for release of a facility for unrestricted use. Until this dose level has ben ascertained, commenting upon this NUREG is futile.

6. There are too many assumptions in this report that do not bear on past performance nor common sense. For instance,
"It is assumed that good housekeeping..." Page 2-13. Even after the accident at TMI#2 and an inspection by a specail team at the TMI#2 site housekeeping remained a problem until the NRC enlisted the cooperation of the top MetEd officer on the site for that specific problem.

Recently, the Phila Daily News carried a story about radioactive mouse feces being found on the TMI site. The assumption concerning housekeeping bears no relationship to reality. Many assumptions , implicit and eexplicit , do not bear any relationship to reality in this NUREG.

Poor assumptions flaw this NUREG beyond redemption. Throw it out and hope that you can do a better job the second time around.

7. DISCLAIMER: I have not had the time or the inclination to critique all the many flaws, errors, and just plain dumbness in this NUREG. Please do not construe my silence on any point as an endorsement of this report, NUREG 0586.

Respectfully submitted,

Marvin I. Lewis
6504 Bradford Terrace
Phila . PA 19149
(215) CU 9 5964.

San Diego Gas & Electric

R. L. MEYER
VICE PRESIDENT—REGULATORY SERVICES

March 19, 1981

DOCKET NUMBER
PROPOSED RULE PR-30, 40, 50, 70, 72
(46 FR 11666)

MAR 24 1981
Office of the Secretary
Docketing & Service Branch

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing & Service Branch

Re: Decommissioning Criteria for Nuclear Facilities: NUREG-0586

Gentlemen:

The San Diego Gas & Electric Company, co-owner of the San Onofre Nuclear Generating Station, has a continuing interest in the regulatory framework (both federal and state) being developed for the decommissioning of nuclear power facilities. Accordingly, SDG&E is pleased to offer the following comments on the NRC's Draft Generic Environmental Impact Statement, specifically relative to the four areas of regulatory objective and the preliminary conclusions.

1. Timeliness:

It is asserted that "completing decommissioning and releasing the facility for unrestricted use eliminates the potential problems of increased numbers of sites used for the confinement of radioactively contaminated materials, as well as potential health, safety, regulatory and economic problems associated with maintaining the site." Such a sweeping assertion must be supported by extensive documented evidence of such "problems" before acceptance is warranted. The number of sites is small when viewed from the perspective of the total number of sites dedicated to industrial use.

Nuclear sites are, by regulation, isolated and desirable for continued energy production utilization (after all, transmission line facilities, among others, are of permanent value). It can be argued with merit that such sites should never be released for unrestricted use by the public. Since decontamination can readily be accomplished after cessation of power production and since continued occupation of the site by the owner precludes public access, it may never be timely to fully decommission a nuclear facility. Thus, there are very significant differences between the reality of site use conversion and the perceived need for total restoration to free public access

The public should not be deluded into expecting the eventual return of all technological facilities and sites to parkland scenes. We should realistically consider the myriad of possible uses for our sites, not creating regulations that preclude a case-by-case determination of the use that is most beneficial to the public.

POST OFFICE BOX 1831 · SAN DIEGO, CALIFORNIA 92112 · TELEPHONE: 714/232-4252

2. Financial Assurance:

It is disquieting to read in the proposed EIS such wording as "while other funding mechanisms,...........may be more costly on a net present worth basis, their economic impact is still small in terms of the total cost to the consumer or licensee." It is this cavalier disregard for the economic consequences of promulgating regulations that has contributed strongly to any doubts there may be as to a utility's financial ability to decommission reactors as required. The conclusion drawn by the EIS on financial assurance does not appear to be supported by factual material.

To the extent that the cost of financing nuclear decommissioning is in the regulatory arena, the participants should be those regulatory bodies who have the responsibility for approving revenue requirement levels and rates to develop those revenue requirements.

3. Planning:

As has been described in the section on "Timeliness" above, the legitimate options for continued site utilization after cessation of nuclear facility operations are virtually boundless. The best such use, based on a cost/benefit evaluation on a site-by-site basis, cannot be predicted with accuracy! In fact, it is a virtual certainty that today's plan (or that prepared prior to acquiring an operating license) will not be the best one. A realistic approach is urged.

A plan should be made for site conversion prior to facility operation. Such a plan will permit the ratemaking regulatory bodies to make appropriate provision for the recovery of the estimated costs over the life of the facility. However, such plan must not be a mandatory prerequirement for licensing as this would be another target for intervenors with no other purpose than to delay projects.

Then, some time prior to the termination of the operating license, a firm plan should be prepared and realistically presented for approval. No viable option for further site use should be precluded! With the concurrence of local and federal authorities, detailed financial plans could be prepared and implemented. We urge that the current emphasis on immediate commitment for release of the facility/site for unrestricted public access be discarded and replaced with recognition of all of the potentially higher public value uses to which such facility/site could be applied!

Re: Decommissioning Criteria for Nuclear Facilities: NUREG-0586

4. Residual Radioactivity Levels:

Clearly the allowable residual levels of radioactivity depend upon site use and public exposure likely to accompany such use. The draft EIS is preoccupied with "unrestricted public access," which is the least likely of the real options for site re-use. Even in this case, excessively restrictive requirements are not justifiable.

It is clear that the allowable residual activity should be established based upon the natural background levels at the specific site. For example, if the public routinely utilizes a local park in which rock outcroppings are present and if such rocks contribute to the background dose, it would be reasonable, if a site were converted to a park, to fix residual levels to that of the existing park! Similarly, if a site were converted to heavy industrial use, acceptable background levels should include recognition of the exposure that would occur as a consequence of the materials of construction of the new facility, the materials in process there, the inherent shielding provided by the facility structures, etc.

In summary, it is not in the public interest to mandate excessively restrictive radioactivity levels before the ultimate best use can be reasonably determined. Again, when the re-use plan has been adopted (about five years from "end-of-life"), residual radioactivity levels can then be established, recognizing on a case-by-case basis the degree of protection of the public required by the specific new use envisioned. It would be unconscionable to fix an arbitrary level to be applied nation-wide and independent of the nature of site re-use.

Conclusions:

The draft EIS seems to overlook the fact that nuclear sites are owned by entities; they are not public lands. Any decommissioning framework that ignores "due process" in treating private property is doomed to endless litigation. Also, the public health and safety concerns must include examination of the benefits to the public that derive from intensive re-use of facilities; the draft EIS must address this issue and offer a mechanism for balancing the various perceptions of public health, safety and benefit.

Sincerely,

R. L. Meyer

Ralph L. Meyer
Vice-President - Regulatory Services

RLM:ch

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,72
(46 FR 11666)

③

State of Wisconsin \ PUBLIC SERVICE COMMISSION

STANLEY YORK, CHAIRMAN
EDWARD M. PARSONS, JR., COMMISSIONER
WILLIE J. NUNNERY, COMMISSIONER
Hill Farms State Office Building
Madison, Wisconsin 53702
(608) 266-1241

File No.

DOCKETED USNRC
MAR 24 1981
Office of the Secretary
Docketing & Service
Branch

March 20, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Dear Secretary:

This letter is in response to your request for comments on the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities. These comments are concerned primarily with the decommissioning of nuclear power plants.

1. The draft EIS reflects an apparent shift (or final policy determination) by the NRC with respect to a number of issues, including whether immediate decommissioning and unrestricted public access after decommissioning should be required, and whether internal reserve funding of decommissioning is appropriate. It was my understanding that these were issues yet to be resolved. Yet the draft EIS couches these items in the framework of regulatory objectives which essentially close the issue for the purpose of the draft EIS. Has the Commission reached any formal decision on these matters?

2. The discussion of Planning on page vi has limited or no applicability for existing nuclear plants. Yet these facilities will be the first to be decommissioned. What requirements would apply to planning for the ultimate decommissioning of existing plants?

3. How will decommissioning vary as a function of the year of design of the LWR? For example, with increased use of reinforcement steel in the containment walls, to what extent will the difficulty and cost of removal increase compared to older existing plants?

4. The draft EIS should discuss the effect of various levels and durations of plant operation on the cost and difficulty of decommissioning. For example, to

what degree will the difficulty be increased if a power plant operated 40 years at a 75% capacity factor compared to 40 years at a 50% capacity factor? If the plant operated only 20 years instead of 40?

5. All costs are given in 1978 dollars. How have costs of decommissioning pressurized water reactors escalated historically? What are projected escalation rates associated with decommissioning pressurized water reactors?

6. Finally, it is presumed that further environmental analysis will be conducted at the time decommissioning is proposed to take place. A number of simplifying assumptions, such as the existence of low level and deep geologic repositories for radioactive waste, may not actually be valid at the time of decommissioning. Is my presumption correct? What would be the effects on costs, safety, and difficulty of decommissioning for a scenario which presumes waste repositories are not available at the time of decommissioning?

Thank you for the opportunity to comment.

Sincerely,

Jerry E. Mendl

Jerry E. Mendl
Division Administrator
Systems Planning, Environmental
Review and Consumer Analysis

JEM/kmw

Q-4 Beverly Apts.
Asheville, N.C. 28803
20 March 1981

DOCKETED
USNRC
APR 1 1981
Office of the Secretary
Docketing & Service
Branch

(4)

U.S. Nuclear Regulatory Commission
Secretary of the Commission
Docket and Service Branch
Washington, D.C. 20555

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70+72
(46 FR 11666)

To whom it may concern:

Regarding Federal Register, page 11666, Feb. 10, 1981: Decommissioning Criteria for Nuclear Facilities ...

The highly difficult, expensive, and potentially disastrous environmental effects of decommissioning a nuclear power facility would be greatly simplified by refusing to allow the licensing and construction of these death's heads in the first place. Other than that, complete dismantlement, and total restoration of the immediate environment, without passing the tremendous cost to electrical consumers, and other taxpayers, is the only proper alternative.

The proliferation of nuclear technology in the form of power plants and military weaponry, if unchecked will signal the death knell of human life on this planet. Your nuclear friends claim its product is risk free, but the wastes it produces are deadly, and remain that way for eons, a constant threat to generations unborn. Cancer rates are climbing at a tremendous rate in the areas of the West that were subject to fallout from nuclear weapons testing. Uranium miners for Kerr-McGee are dying because of the inhalation of radioactive radon gas in the porrly ventilated mines.

The U.S. government must realize that the nuclear power industry is crumbling technically, economically, and politically, and withdraw its support from this capital intensive totalitarian mega-corporation. The time is upon us when citizens will refuse to bleed their hard earned dollars into utilities who continue to grow richer, while poisoning those same patrons with hazardous wastes and cancer! This nuclear industry is not listening to those working within the legal limits of our democratic system. People will come to hate, then halt this death machine, not by acts of violence, but by acts of conscience.

This public outcry against nuclear proliferation must be heard! Cease construction of plants in progress! Call a moratorium on further licensing and development of all nuclear technology! Shut down and dismantle existing plants! Is not the sanctity of life greater than the pursuit of profit!

Sincerely,

Jay S. Gertz

Jay S. Gertz

(8)

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,7
(46 FR 11666)

400 Chestnut Street Tower II

April 21, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Docketing and Service Branch

Dear Sir:

TVA is pleased to provide comments on NUREG-0586, "Draft Generic Environment Impact Statement on Decommissioning of Nuclear Facilities," as noticed in the February 10, 1981 Federal Register (46 FR 11666-11668). We agree with the conclusion of the NUREG that decommissioning can be performed with relatively small adverse impact on the health and safety of the public. However, we believe the report should place additional emphasis on the fact that the various decommissioning alternatives result in low levels of radiation doses to the public. We believe these facts are important in our efforts to assure the public that decommissioning activities can be performed with low risk.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Regulation and Safety

Enclosure
cc (Enclosure):

Executive Secretary
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
1717 H Street, NW
Washington, DC 20555

Mr. Fred Stetson
AIF, Inc.
7101 Wisconsin Avenue
Washington, DC 20555

ENCLOSURE

TVA COMMENTS ON NUREG-0586

1. Due to the limited number of low-level radioactive waste disposal sites across the country, a number of utilities are considering the construction of low-level radioactive waste storage facilities at reactor sites. Therefore, we believe the document should specifically address the decommissioning of low-level radioactive waste storage facilities.

2. We believe that the decommissioning alternatives as described fail to consider the concept of reuse of the site by the utility for an additional generating facility. In that case, the utility would retain ownership and the site would not have to be released for unrestricted use and various alternatives under SAFSTOR and ENTOMB would then become more acceptable. We recognize that this concept would have to be evaluated on a case-by-case basis. Therefore, we recommend that the document address this concept and that any resultant regulations allow sufficient flexibility for such options.

3. The document cites potential health and safety problems attributable to delaying decommissioning and the advantages of returning the land to the public domain as soon as possible as reasons why decommissioning activities should be completed as soon as possible. We disagree. In fact, we believe that there are public health and safety implications from immediate decommissioning. We recommend that the DECON option allow for some time for decay that would reduce the dose rates to cleanup workers. This decay time could be allowed for in the schedule of the decommissioning activities and would not significantly lengthen the completion of DECON.

4. While TVA has no expertise on acceptable radiation limits, we note that information available in this report suggests that the dose limit for a decommissioned nuclear plant site could be about 5-10 mrem/year. In fact, the discussion on pages 2-11 seem to indicate that levels are 5 mrem/year are acceptable. These statements appear to contradict the conclusion that dose rates slightly above 5 mrem/year "are probably unacceptable." The report states that "the actual dose level in most areas of the site is probably lower than the level at which the instruments can certify." Further, the costs to survey to a 1 mrem/year level are given only as "costly." We believe the issue should be clarified and the standard of ALARA as applied to the plant be adopted for decommissioning requirements.

5. We believe that any regulations adopted by NRC should permit a wide range of flexibility, both in the method employed for decommissioning and in the funding of the work. The unique situation of each licensee should be judged on its own merits.

TVA is a financially strong organization which will have the resources to carry out decommissioning. TVA uses a technique similar to the "unfunded reserve method" to account for decommissioning costs. We believe this approach is consistent with the requirement of the TVA Act to provide electric energy at the lowest feasible cost, and that it appropriately imposes the cost of electric service on the users of that service. We also believe that there is adequate assurance that TVA will have financial resources required to decommission its nuclear facilities.

6. The EIS contends that decommissioning mitigates the impacts of facility shutdown by providing new employment, which could be larger than many of the operations work forces. If so, the potential for impacts at the completion of decommissioning should be addressed. Otherwise, it would be appropriate to incorporate the impacts of employment loss from shutdown in any assessment of impacts from decommissioning.

   The assessment of socioeconomic impacts for the various nuclear facility types are inconsistent. For example, there is no mention of employment loss in the discussion of the electrical generating facility types (chapters 4 and 5), while employment loss is included in other chapters for other facilities. Each chapter on each facility type should address and quantify the probable loss of employment from shutdown and decommissioning.

   The loss of tax revenue from shutdown and decommissioning could be a significant impact to a local jurisdiction, particularly if very rural, and should be addressed.

9
PR-30, 40, 50, 70, 72
(46 FR 11666)

APR 24 1981

Mr. Samuel J. Chilk
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTN: Docketing and Service Branch

Dear Mr. Chilk:

In accordance with Section 309 of the Clean Air Act, as amended, the Environmental Protection Agency has reviewed the Draft Generic Environmental Impact Statement (DGEIS) on Decommissioning of Nuclear Facilities (NUREG-0586).

The document is well-written and referenced, and based on the material presented, we believe that there would probably be very limited impact on the environment and public health from the proposed actions. However, the technical basis for the action and a justification that the impacts are as low as reasonably achievable (ALARA) are lacking. We did have difficulty confirming results in the document due to the heavy incorporation of referenced material. The health and economic data presented are mainly in the form of summmary tables with no presentation of methods used in calculating them. We are also concerned with a proposed dose rate limit of 10 millirem per year (mrem/year) which can be interpreted to exceed the limitations in 40 CFR 190, the uranium fuel cycle standard and EPA's proposed guidance on transuranic concentrations in the environment.

Based upon our review, we have rated this Draft Generic Environmental Impact Statement as ER-2 (environmental reservations and further information desired). This rating will be published in the Federal Register.

Comments of a general and specific nature are enclosed. Should you have any questions, please call Dr. W. Alexander Williams of my staff (755-0790) or Mr. Terrence McLaughlin of EPA's Office of Radiation Programs. (557-8977)

Sincerely yours,

William N. Hedeman, Jr.
Director
Office of Federal Activities

Enclosure

COMMENTS OF THE
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
ON THE
U. S. NUCLEAR REGULATORY COMMISSION'S (NRC)
DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT
ON
DECOMMISSIONING OF NUCLEAR FACILITIES (NUREG-0586)
April 1981

General Comments:

1. The ALARA concept and how it will be applied to decommissioning in the future should be discussed further.

2. If the weighting factors used in Report 26 by the International Commission on Radiological Protection (ICRP) are employed to to calculate individual organ dose rates from the 10 mrem/year whole body dose rate, the following are the results:

A lung dose rate limit of about 80 mrem/year;
A red bone marrow dose rate limit of about 80 mrem/year;
A bone surface dose rate limit of about 333 mrem/year;
and a thyroid dose rate limit of about 333 mrem/year.

EPA has difficulty accepting these dose rates because even though decontamination and decommissioning do not technically fall under 40 CRF 190, the EPA Uranium Fuel Cycle (UFC) Standards, these dose rates significantly exceed those stipulated in 40 CFR 190. Also, these dose rates are in excess of EPA's proposed guidance on transuranic isotopes concentrations in the environment. This guidance limits exposures to, "...a. 1 millirad per year to the pulmonary lung, or b. 3 millirad per year to the bone." Using a quality factor of 20 for alpha radiation, these limits convert to 20 mrem/year to the lung and 60 mrem/year to the bone. Further, the UFC standards set limits of 25 mrem/year to the whole body or any organ except the thyroid and 75 mrem/year to the thyroid. If the Nuclear Regulatory Commission (NRC) wishes to use ICRP-26 then all of the implied dose rate limits for individual organs exceed EPA's proposed guidance and existing UFC standards. Before using ICRP-26 we suggest that NRC assess its effect on existing guidance and regulations. In the meantime, and until EPA can develop standards, we believe that a proposed regulatory limit of 10 mrem/year to the whole body <u>or</u> <u>any</u> <u>organ</u> will result in little significant health risk.

3. The individual and population risks should be considered for specific actions. This will allow a more realistic and appropriate assessment of risk involving long-term exposures,

e.g., doses from inhalation and doses from living in a contaminated area. Risks of genetic effects and nonfatal cancers should also be similarly discussed.

4. In many places in the subject document there is a discussion of a dose rate limit of 1 mrem/year to the whole body. The statement is made that any exposures above 1 mrem/year would need justification for decontamination and decommissioning activities. We find no basis for this statement in the subject document or in NRC policy, and believe that the use of only the 10 mrem/year limit, along with ALARA considerations, is sufficient to justify the chosen level of residual activity to be achieved.

5. It is not clear in the EIS whether previously decommissioned facilities will be expected to meet the dose-level and other criteria proposed by either the NRC or EPA. The residual dose-level requirements, if any, which will be imposed on such facilities, and enforcement mechanisms available to ensure compliance should be discussed in the FGEIS.

6. With regard to future land use, the DGEIS utilizes a worst-case dose pathway scenario, which assumes construction of a housing project on the decommissioned site, to calculate potential maximum human exposure levels. In reality, whether or not such "worst-case" types of unrestricted use would be acceptable from a dose exposure standpoint, they may not be palatable to the public for other reasons. In such instances, what mechanisms, such as deed restrictions, are proposed to ensure that future uses of the land do not include schools, housing projects, or other such sensitive receptors?

7. We believe that the discussion of financial assurance mechanisms for decommissioning existing facilities is incomplete. The ability to raise the necessary funds and the economic impacts resulting from the pass-on of these costs may be quite different for facilities that have completed significant parts of their operating lifetimes without setting aside funds for decommissioning than for those new facilities which can allocate the cost of decommissioning over their entire lifetimes. There should be more consideration of the costs of decontaminating and decommissioning facilities now in operation.

8. Where cost figures are presented, the FGEIS needs to be more explicit as to whether the costs are discounted or undiscounted. Confusion results because the tables do not indicate discounted costs, while the costs from present value analyses are frequently mentioned in the text. To properly compare the costs of alternative plans which would take place over different time frames, it is important that the type of cost being considered is clearly presented.

Specific Comments:

1. Page 0-31: The waste volumes in Section 0.12.1.2 are in error. Either 1,020 cubic meters or 11,000 cubic feet needs to be changed.

2. Page 2-9: The Energy Reorganization Act of 1974 only recognized EPA's responsibility to establish radiation dose standards; it was the President's Reorganization Plan No. 3 of 1970 that gave EPA that responsibility and authority.

3. Page 2-10: 40 CFR 190 also sets organ dose rate limits of 25 mrem/year to other than the thyroid an 75 mrem/year to the thyroid.

4. Page 4-3, Section 4.3.1, third paragraph: Deep geologic disposal will obviously not cost $850,000 million.

5. Page 4-4: Table 4.3-2 is apparently titled incorrectly. The table deals with radiation exposures and not estimated costs.

6. Page 5-11: What is the fifty-year DECON option? It is neither mentioned nor discussed anywhere else in the document.

7. Chapter 10: Discussions concerning the decommissioning of Uranium Hexaflouride Conversion Plants refer to experience from current decommissioning of the Weldon Springs Plant. Such work is not now underway nor is it expected to begin soon. The Plant has been under guard for 15 years with little preventive maintenance and no clean-up activities. Various studies have been performed and reported. These have indicated a need for much more time than the total of one year for completion of all estimated work (p. 0-25). In fact, the cost of these studies probably approaches the total estimated clean-up cost of $2.3 million. In addition clean-up of such a facility does not consider the major task of decommissioning the raffinate disposal pits.

8. EPA studies have shown traces of technitium-99 (Tc-99) at uranium enrichment plants. We would expect Tc-99 to be present at conversion plants, and we recommend consideration of any impacts in the Final GEIS.

C-E Power Systems
Combustion Engineering, Inc
1000 Prospect Hill Road
Windsor, Connecticut 06095

Tel 203/688-1911
Telex 99297

POWER SYSTEMS

(10)

PR-30,40,50,70,72
(46 FR 11666)

April 22, 1981
LD-81-021

Secretary of the Commission
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Docketing and Service Branch

Subject: Comments on Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (46 FR 11666 and FR 11667)

Gentlemen:

This letter provides Combustion Engineering's comments on the draft generic environmental impact statement (NUREG-0586) referenced in the subject federal register notices. These comments are provided below.

1. Sections entitled Planning (page vi) and Initial Plans (page 0-40) recommend that a decommissioning plan be submitted prior to commissioning of a nuclear plant. Our principal concern regards the subsequent implementation of this recommendation. Since decommissioning is a long range issue of essentially known magnitude there is no compelling reason that a near term operating license applicant have a decommissioning plan in effect prior to receipt of its operating license. We feel that any cost-benefit analysis would certainly demonstrate that the costs associated with the postponement of an operating license to implement this recommendation would far outweigh any benefits received by having such a plan in effect before commissioning. Therefore, we recommend that some reasonable period of time be allotted for the preparation of this decommissioning plan, one which will not impact plant licensing or operation.

2. Table 4.3-2 (page 4-4) should have units of "man rem" and not "$ millions".

3. A number of sections address allowable residual radiation exposure limits following decontamination. The values, which range from 0-10 mrem/yr., appear unreasonable in terms of detectability and sampling feasibility. It is suggested that the selection of the residual radiation levels be based on the findings of the Radiation Policy Council, which has been given the task of defining appropriate minimum radiation limits of exposure (45 FR 69611). It is expected that the radiation levels selected by the Council will be applicable to decommissioning operations and, by using these numbers, policy consistency will be ensured.

4. The NRC suggests..."There are many aspects of facility design and operational procedures that could greatly affect decommissioning in terms of improved health and safety and reduction of radioactive waste volume." Combustion Engineering agrees that operational procedures employed over the life of the plant (such as periodic removal of crud buildup) would facilitate ultimate DECON of a plant and design considerations in the initial plant design might also contribute. However, we feel that, in view of the operational ALARA considerations currently designed into the plant, the prospect of significantly improving plant design to accommodate DECON considerations will be minimal.

   If the NRC does propose that utilities consider design features or modifications specifically directed toward facilitating the DECON option (either during the original design or subsequent operation), all such modifications should be clearly justified by a rigorous cost-benefit analysis.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:dac

Detroit

Wayne H. Jens

(11)

PR-30,40,50,70,72
(46 FR 11666)

APR 24 1981

April 20, 1981

Mr. Samuel J. Chilk
Secretary of the Commission
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Docketing and Service Branch

Dear Mr. Chilk:

On February 10, 1981, the Commission published a notice in the Federal Register, 46 FR 11666, indicating the availability of a draft Generic Environmental Impact Statement (GEIS) concerning decommissioning criteria for nuclear facilities and requesting comments on that document. The Detroit Edison Company, as a licensee of the Commission for the construction of a nuclear power plant, will be affected by the Commission's action in this area and, therefore, offers the following comments.

The Company objects to the way the GEIS defines decommissioning. Such a restrictive definition ignores the reality that numerous nuclear facilities have, in fact, been decommissioned over the years according to commonly accepted definitions of that term and that those decommissionings have been accomplished at relatively low cost and such that there have been no adverse impacts on the environment. To define decommissioning as the GEIS proposes only drives up the cost unnecessarily without adequate justification.

Under the section entitled "Planning," a statement is made that, "it is important that the licensee decommissioning plan be developed and approved prior to commissioning of the facility." The Company strongly objects to the content of this statement. A decommissioning plan submitted 40 years or more before the decommissioning is to occur would have to be either so general as to be meaningless or would ignore scientific and technical advances which would occur over that time period. The Company believes that it is sufficient at this stage of licensing the facility that the NRC and the licensee know that decommissioning can be accomplished and know the approximate cost.

Further, the Company does not agree as to the reasonableness of choosing 10 mrem/yr dose equivalents expressed on pages vi and vii. This choice of a residual dose limit does not appear to be reasonable when examined in light of a person moving from an area such as Detroit to Denver, which would result in that person receiving an additional ten times a 10 mrem/yr residual dose. The Company would suggest at a minimum that the residual dose limit be changed to the 100 mrem/yr.

Based on the Company's experience, it does not agree with the judgment made on page 0-7 that "decontamination costs of a facility are essentially independent of the level to which it must be decontaminated."

On page vii, it is stated that decommissioning as defined in the GEIS has "major beneficial impacts" releasing land that "can be used with great benefit." It is not clear at all that the one or two acres of land occupied by a fenced-in, moth-balled nuclear steam supply system with its associated buildings has any more value than the somewhat larger piece of land that has to be used as a burial ground. The options now available in Regulatory Guide 1.86 should be left open so that advantages and disadvantages for a utility and its shareholders and customers as well as the total environment can be weighed in a decision on how best to proceed on decommissioning a nuclear facility.

Contrary to the statement made in paragraph 0.1.5, according to the proposed restrictive definition, only one (not 15) reactor has been decommissioned.

The Company does not believe the GEIS adequately supports the statements that eliminate SAFSTOR as an option, except for 30 years, and that ENTOMB is not a viable option.

The Company disagrees with the philosophy contained in the last sentence of paragraph 0.2.7 on page 0-8; rather, it believes that if permanent waste disposal capacity is not available, then decommissioning activities should not be commenced until it is, except for limited activities needed to immobilize material which could otherwise migrate.

Further, a comparison is made in paragraph 0.4.4 on page 0-12 of 17,900 m^3 to 1,160 acres that the Company does not believe is valid. A decommissioned plant does not restrict the use of all of the 1,160 acres because there is no longer the same need to maintain an exclusion zone once the plant is decommissioned.

There is also a statement made in paragraph 0.4.5 on page 0-12 that "100-year SAFSTOR is not a reasonable option . . . with little benefit in dose reduction compared to 30-year SAFSTOR." This, once again, fails to recognize that progress will be made during the next 100 years in robot development or in methods development. The Company suggests the GEIS be revised to reflect the probability of technological advances.

In addition, Co-60, which can be a major isotope to consider in decommissioning, decays away in 50 to 100 years.

The Company supports the internal unfunded reserve as the mechanism to be used for nuclear decommissioning funding. Section 2.6 on financial assurance reaches the conclusion, "Since the cost of decommissioning is only a small fraction of the cost of commissioning, there should not be any significant financial burden on the applicant." The Company does not agree with this conclusion because it is not based upon sufficient evidence. Due to the variables surrounding the cost of decommissioning, the tax implications, and the funding mechanism that could be used, the type of funding that could be recommended might impact our customers and Company significantly. This has been shown in a generic hearing before the Michigan Public Service Commission (Case No. U-6150).

The Company is opposed to any type of prepayment, surety bond, sinking fund, insurance, or any external fund methodology to provide for the funding of decommissioning a nuclear facility at the end of its useful life.

The Company's position supporting internal funding has been entered into the public record in generic hearings, addressing the issue of funding for nuclear decommissioning, before the Michigan Public Service Commission in Case No. U-6150. The testimony, exhibits, and studies filed in that case reveal that an internal fund is the lowest cost method to the ratepayers, provides reasonable assurance funds will be available, and provides flexibility with regard to how accruals will be made into the fund.

Copies of the Company's studies and filing in the above-mentioned case are available upon your request.

The above statements have been offered for the Commission's consideration with the hope that the revised GEIS will be an improved document.

Sincerely,

VPNO-81-81 cc: G. D. Calkins

Deloitte Haskins+Sells

(12)

PROPOSED RULE PR-30, 40, 50, 70, 72 (46 FR 11666)

APR 24 1981

One Main Place
Dallas, Texas 75250
(214) 748-6601
Telex 732648

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Nuclear Regulatory Commission
Washington, D.C. 20555

April 15, 1981

Dear Sirs:

These comments on NUREG-0586, Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities dated January, 1981 relate primarily to financial aspects and, for the most part, are general in nature.

The reliance of NUREG-0586 on NUREG-0584 and NUREG/CR-1481 is obvious. As pointed out in my previous comment letters of September 29, 1980 and February 27, 1981, the latter two NUREG's do not provide the balanced analysis of the financial aspects of decommissioning that is required for consideration in the development of the Environmental Impact Statement. Rather than repeat my previous comments here, I am attaching a copy of a summary. As is obvious from this summary, I conclude that both NUREG's are flawed.

It is unreasonable to exclude any method of financing routine decommissioning other than funding at commissioning, unless coupled with insurance. The Commission should pay more than lip service to the need to provide for flexibility in implementing financing mechanism, and should recognize that there is no one best way to decommission or to finance it.

The issue of routine decommissioning of a power reactor should be separated completely from the issue of cleaning up an accident. These issues are currently not separated, resulting in the accident situation unreasonably coloring consideration of the financial aspects of routine decommissioning. If forthcoming regulations concerning routine decommissioning are to achieve a reasonable balance between health and safety, economic, and political considerations, separation is an absolute necessity. It is imperative that the NRC Staff recognize that their proposed financial assurance requirement could significantly affect the economic viability of nuclear fuel for electric generation. If assurance requirements end up adversly affecting the choice of nuclear fuel for electric generation, it should result from a balanced analysis and not from a concern for accidents that colors the analysis of requirements for routine decommissioning.

The NUREG should be reviewed in detail by the authors to identify all the existing internal inconsistencies and inconsistencies with referenced support studies. Internal inconsistency should be eliminated, and inconsistency with support studies should be either eliminated or explained.

The value of generation sites is such that the definition of unrestricted use is probably not suitable for power reactor sites. The definition results in unreasonable limits on decommissioning processes for power reactors.

The major financial problem with NUREG-0586 is its reliance on two other NUREGs that do not provide a reasonably balanced analysis of the financial aspects of decommissioning. It seems clear that a balanced analysis will not appear until such time as the issue of routine decommissioning is separated from the issue of cleaning up an accident.

Regards,

John S. Ferguson

John S. Ferguson

Enclosure:
JSF:

COMMENTS ON NUREG-0584 AND NUREG/CR-1481

It is difficult to comment on NUREG-0584 independently from NUREG/CR-1481, as they make liberal use of each other. The Forward to NUREG-0584 Revision 2 indicates it "will be utilized as background information in the formulation of recommendations by the NRC Staff on policy in the use of financial assurance". It is my belief that recommendations by the NRC Staff on policy should be founded on a balanced presentation of background information. Neither of these NUREG's can be characterized as balanced. In addition, they both contain some information that is misleading and some that is in error.

Generally accepted accounting principles and regulatory rules concerning depreciation are very significant to the discussions in NUREG-0584 and NUREG/CR-1481, since the depreciation provisions for decommissioning must be authorized by rate regulators and the financial statements of the entities responsible for decommissioning must be certified by the accounting profession. Lack of any discussion of this subject in either NUREG is an omission that requires rectifying.

The authors of both NUREG's take as given a definition of liquidity that defies logic; that capital recovery amounts collected from customers and reinvested internally by the utility are not liquid and collections invested in anything other than the utility are liquid. The authors obviously have little faith in the adequacy of rate regulation. The actions of the commissions regulating the General Public Utilities Company operating companies reinforce this pessimistic view of the adequacy of rate regulation, and vividly illustrate the political nature of rate regulation. The political nature of rate regulation should be recognized by the NRC through providing rate regulators wide latitude in selecting funding methods that will assure the availability of funds for decommissioning.

The analyses in NUREG-0584 and NUREG/CR-1481 are tilted away from internal funding approaches. However, even with the tilt, NUREG/CR-1481 concludes "that no alternative dominates". It seems clear that a more balanced approach would favor internal funding, leaving the regulator with the determination of which of the several methods of capital recovery that meet generally accepted accounting practices and regulatory rules he should allow. Whether there is agreement or not that this tilt exists, any regulations that might ensue should ensure that service rate regulators have the flexibility they require to respond to the particular circumstances surrounding the facilities involved.

It would be helpful if discussions of the methods of capital recovery (approaches to financing the decommissioning) used terminology that makes it clear to the reader exactly what method is being discussed. The sinking fund method of depreciation is not a new concept, and its most common application is as an internal method of depreciation. I doubt that I am the only depreciation analyst who finds confusing the use of the term "sinking fund" to refer to external funding approaches. Accurate use of terminology would go a long way toward eliminating the need to search studies for a description sufficiently detailed to discern the particular method being discussed.

Is the equal annual revenue stream in terms of constant dollars, defined as desirable on Page IV-12 of NUREG/CR-1481, really equitable? It has the effect of pushing revenue requirements off to future customers, a process I have difficulty defining as equitable. My difficulty may be due in part to knowledge that the only capital recovery method I am aware of that would result in such a stream of revenue requirements violates the generally accepted accounting practices and regulatory rules applicable to depreciation. Violation of generally accepted accounting practices is not to be taken lightly. Capital recovery determined in a manner consistent with accounting practices and regulatory rules should determine revenue requirements, not the other way around. Assumptions concerning the pattern of revenue requirements should not be allowed to dictate the capital recovery, particularly if based on a controversial definition of equity. Internal Sinking Fund and Internal Modified Sinking Fund Depreciation generate unique patterns of capital recovery and revenue requirements that are very significant to the discussion of equity. It is precisely these patterns that cause Internal Modified Sinking Fund Depreciation to be appealing to regulators.

The authors of NUREG/CR-1481 correctly point out that a flexible approach to capital recovery of nuclear decommissioning costs is very important. This need cannot be over stressed. The degree of financial assurance that will result from the NRC's policy reevaluation will vary directly with the degree of flexibility allowed.

Internally invested methods reduce financing requirements, which in turn reduce risk and cost of money, and thereby enhance the financial assurance aspects of decommissioning. Prepaid Invested Fund must be evaluated as having a detrimental impact on the financial viability of the utility industry, since it would require a large amount of borrowing that would be done solely for the purposes of investing. Thus, a method claimed to meet a need for financial assurance would actually have a detrimental effect on financial viability. Actions of governmental bodies too often have a result in conflict with the expressed intent. The need for financial assurance should not be allowed to become another example.

NUREG/CR-1481 suggests the future income tax reduction resulting from the actual expenditures for decommissioning be given to current customers through normalization. The result would be to reduce current revenue requirements, the opposite effect usually associated with normalization.

The regulatory arena provides two choices for handling differences between book depreciation and tax depreciation. These choices are normalization and flow through. Two distinctly different situations exist for the creation of tax benefits. The most familar situation is when a current benefit is either given to current customers or is spread over the life of the facility creating that benefit. The other situation is when a future expenditure is expected to create a tax benefit at that time. While it can be argued that a current benefit should be normalized and a future benefit should be flowed through, competent regulation would not allow flowing through a current benefit and normalizing a future benefit. As a compromise position, it would be reasonable to handle both present and future benefits through flow through or handle both through normalization. It is well known that tax depreciation is for purposes of financing, not recovery. It is also well known that the intent of Congress in providing for high depreciation rates for tax purposes, was to provide industry with additional cash for expansion and modernization. Normalization allows this intent to occur, whereas flow through does not. Therefore, normalization of a present benefit is consistent with the existence of that benefit and should be allowed.

While there can be no question as to the existence of a benefit presently, the assumption of a future benefit carries with it a certain amount of uncertainty as to the timing of the benefit and whether the benefit will in fact exist at that time. In view of this uncertainty, it can be argued that the benefit should not be distributed until such time as its existence is confirmed.

By limiting his discussion of differing regulatory treatment of differences between book and tax depreciation to their existence, the author of NUREG-0584 has avoided the trap the authors of NUREG/CR-1481 set for themselves. The authors of NUREG/CR-1481 recommend normalizing the tax reduction from the deductability of the actual expenditures for decommissioning. Normalization distributes the potential benefit to customers on a pro-rata basis over the lifetime of the nuclear generating unit rather than to the customers existing when the expenditures would be made and the benefit would exist. The recommendation of normalization implies the eventual existence of the benefit, which, in turn, implies sufficient taxable income to make use of the ultimate tax deduction. This implied financial viability at the end of plant life is in direct conflict with the contention of the authors of NUREG/CR-1481 that external funding will provide needed financial assurance because of the uncertainty that utilities will be financially viable at the time decommissioning is required. If the authors are really serious in suggesting normalization, they must not believe their own contention that future financial viability of utilities is subject to question.

Prepaid Invested Fund is the most expensive for the customer and Straight-Line Depreciation is least expensive, but the differentials have been greatly understated by the insistence of the authors of NUREG-0584 and /CR-1481 to make comparisons based on the present worth of revenue requirements and not on the revenue requirements themselves. Customers don't pay for electric service based on present worth and regulators don't set rates based on present worth. Any meaningful comparison of the impact of alternative capital recovery methods must include the impact on customers in terms of current dollars. Decisions made on the present worth of current dollars do not recognize the actual costs imposed on customers and can be misleading, since relative rankings of alternatives will depend on the magnitude of the discount rate used for the present worth calculation.

The authors of NUREG/CR-1481 point out that, even in terms of present worth, Progressively Paid Invested Fund is twice as costly as Straight-Line Depreciation, and Prepaid Invested Fund is three times as costly. The authors claim these differences are not significant. My experience with rate case issues concerning the capital recovery requirements for nuclear decommissioning is that regulators probably would not agree with the claim that a two or three-to-one differential is not significant.

My studies indicate that funding at commissioning is the most expensive in terms of revenue requirements, even if collections paid to an external fund are tax deductible upon collection and those held internally are not. My conclusions have been confirmed by other studies, such as one made by the Staff of the Michigan Public Service Commission for the generic decommissioning proceeding, Case U-6150.

I was surprised that Revision 2 of NUREG-0584 still includes the discussion of tax deductibility of collections that was in Revision 1. Revision 2 of NUREG-0584 states utilities may be able to obtain an IRS ruling that, under certain conditions, the annual collections from customers to feed an invested fund are an expense for Federal income tax purposes in the year collected and indicates the same result could be obtained with a state administered fund. Both claims are incorrect.

Three utilities in Ohio have gone so far as to request a ruling for an external fund which I believe was structured in the manner indicated on pages 19 and 20 of Revision 2 that the author claims "may be eligible" for not recognizing the decommissioning expense as income in the year collected. The key words must be "may be", as the Ohio utilities withdrew the request when advised that the IRS would rule adversely. Others have evaluated the impact of state administration on taxability and have concluded that the only way to obtain tax deductibility in the year collected is through legislation. The NRC Staff will be seriously misled if they rely on the discussions of tax deductibility in Revision 2 of NUREG-0584.

While Revision 2 of NUREG-0584 is a little better balanced than Revision 1, the conclusions are nearly identical. The statements concerning the ability to reduce the costs of Prepaid External Fund and Progressively Paid External Fund through state administration that would cause deposits and earnings to be tax exempt are a serious flaw in the conclusions of Revision 2. As indicated above, this is not true for deposits. The only way for earnings to be tax exempt is if they are from investments in tax exempt securities.

CONCLUSION

Considerable revision will be required if NUREG-0584 is ever to perform its intended function; utilization as background information in the formulation of recommendations by the NRC Staff on policy in the use of financial assurance. The current draft does not provide the balanced discussion of this subject that the Staff should have. Neither does NUREG/CR-1481.

(13)

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,72
(46 FR 11666)

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April 16, 1981

DOCKETED
APR 24 1981
emp

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Docketing and Service Branch

Re: Docket No. NUREG0586

Gentlemen:

Attached for filing in the captioned docket is an original and five xerox copies of "Comments of Northern Michigan Electric Cooperative, Inc."

Your very truly,

Robert C. Klevorn

RCK:pjt

Enc.

13

PR-30, 40, 50, 70, 72
(46 FR 11666)

DOCKETED
USNRC
APR 24 1981
Office of the Secretary
Docketing & Service

UNITED STATES OF AMERICA

BEFORE THE NUCLEAR REGULATORY COMMISSION

Decommissioning criteria for)
Nuclear Facilities)

Docket No. NUREG-0586

COMMENTS OF
NORTHERN MICHIGAN ELECTRIC COOPERATIVE, INC.

1. Northern Michigan Electric Cooperative, Inc., (hereinafter called "Northern") is a non-profit cooperative supplying electric generation and transmission service to Its three member/owned cooperatives, at wholesale, within Northern's service area in parts of seventeen counties being Alpena, Antrim, Benzie, Charlevoix, Cheboygan, Crawford, Emmet, Grand Traverse, Kalkaska, Leelanau, Manistee, Missaukee, Montmorency, Oscoda, Otsego, Presque Isle and Wexford, being approximately the northern one-third of Michigan's Lower Peninsula, and maintains its principal office at 1050 East Division Street, Boyne City, Michigan 49712.

2. Northern is solely owned by Cherryland Rural Electric Cooperative Association, whose address is U.S. 31 South, P.O. Box 500, Grawn, Michigan 49637; Presque Isle Electric Cooperative, Inc., whose address is 19831 M-68 Highway, Onaway, Michigan 49765; and, Top O'Michigan Rural Electric Company, whose address is 1123 East Division, Boyne City, Michigan 49712, which have executed all-requirements contract with Northern.

3. Northern is a public utility regulated in the State of Michigan by the Michigan Public Service Commission.

4. Northern has an undivided ownership interest, as a tenant in common, of 11.22% of the Enrico Fermi Nuclear Unit No. 2, presently under construction in Frenchtown Township, Monroe County, Michigan, and by reason of such ownership is an intervenor in Case No. U-6150 entitled "In the Matter of the Establishment and Treatment of Nuclear Plant Decommissioning Funds" now pending as a generic hearing before the Michigan Public Service Commission.

5. Northern has an interest in this proceedings in as much as it may be bound by the adoption of a proposal regarding the establishment and funding of decommissioning funds and as a result of federal regulations.

6. Northern is not regulated by the Federal Government in that all of its transactions are intrastate subject to those regulations adopted by the Rural Electrification Administration in that Northern is a 100% debt financed cooperative regulated by the Rural Electrification Act and whose funding of long-term obligations is totally financed by the United States Government acting through the Administrator of the Rural Electrification Administration.

7. Northern, as a non-profit cooperative owned by Its members, has two primary purposes which would be to pay for all costs associated with decommissioning, and also to pay for costs associated with a nuclear accident not covered by insurance.

8. Cooperative philosophy and funding is very different from the objectives of an invester owned utility. Where an investor owned utility properly seeks to maximize revenue and profit, a cooperative being a not for profit corporation seeks to minimize expense. Revenue and expense to a cooperative are merely additions or deletions to member owned equity.

9. Northern agrees the public health and safety is paramount and further agrees there should be reasonable assurance of the availability of funds upon decommissioning. Northern insists

that its cooperative obligations are to maximize interest earned by any fund after meeting its public obligations as any surplus from sums so ear-marked and collected from its members should be for the member/owner's benefit. Northern would oppose any effort by government to gain control of the member equity as confiscatory since Northern is of the sound conviction that government can only maximize expense----not income. Any decommissioning funds or other costs are invisioned by Northern to be principally composed of debt instruments from the United States Government. Depending on dollar volume and subject to cooperative control, a series of banks or investment bankers would manage the fund's assets subject to the cooperative's direction. That part of rates established by MPSC, which would be in addition to present rates paid by the cooperative member/owners, and should be periodically scrutinized by MPSC and adjusted up or down as experience would dictate.

10. Northern would not propose to invest any portion of decommissioning or insurance funds collected as a part of rates in additions to its electric plant. Northern believes the fund must be internally controlled as it and its members are convinced Northern's proposal will ensure the public need for assurance concerning the availability of funds upon decommissioning, and will also ensure that our member/owners pay the smallest amount necessary consistent with the need to protect the public including our own members and that costs can best be controlled when managed by the cooperative itself.

Respectfully submitted,

Clyde L. Johnson

Clyde L. Johnson
Executive Vice President

Robert C. Klevorn
General Counsel, Northern
Michigan Electric Cooperative, Inc.
215 South Lake Street
Boyne City, MI 49712

xc: All parties of Record
MPSC Case No. U-6150

(14)

PR-30, 40, 50, 70, 72
(46 FR 11666)

The Light company Houston Lighting & Power PO Box 1700 Houston, Texas 77001 (713) 228-9211

April 6, 1981
AC-HL-AE-500
ST-HL-AE-648
SFN: V-0100

emp

Mr. Samuel J. Chilk
Secretary to the Commissioners
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Chilk:

Draft Generic Environment Impact
Statement on Decommissioning of Nuclear
Facilities, NUREG-0586

Houston Lighting & Power Company has reviewed the above NUREG and offers the following comments:

1. Requiring a decommissioning plan to be developed and approved prior to the commissioning of a nuclear facility could have a significant negative impact upon licensing schedules. The current licensing procedures require the validation of the financial stability of the licensee to own and operate a nuclear facility and to carry out regulatory obligations. This should suffice. Requiring the licensee to provide specifics on how these obligations will be met after a period of 30 to 40 years is unreasonable. For example, the specifics of decommissioning a facility such as TMI after the accident and for another facility which has reached the end of its useful life without experiencing such an event are widely varied. This type of variance could carry over into all aspects of decommissioning with its associated decontamination and personnel exposure concerns.

2. The assumptions used in estimating the environmental and economic impact of decommissioning will likely change many times during the operating life of a plant. For example, a regulatory change to reduce

allowable personnel exposures could result in a decommissioning cost of 2 to 5 times that estimated under current personnel exposure guidelines. Changing waste disposal requirements could have a similar influence.

3. The decommissioning cost estimates provided in this report for power facilities are considered to be too low. One basis for this is the operational decontamination of the Dresden facility which cost approximately $30 million. Waste disposal costs alone could account for most of the $33.6 million estimated in this report for decommissioning a PWR.

Very truly yours,

C.G. Robertson

C.G. Robertson
Manager
Nuclear Licensing

TWB/dmh

(15)

DOCKET NUMBER
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April 21, 1981

DOCKETED
APR 24 1981
Office of the Secretary
Docketing & Service
Branch

DIRECT DIAL NUMBER
(216)

Secretary of Commission
United States Nuclear
Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

In re: Decommissioning Criteria for Nuclear Facilities; Comments Concerning Draft Generic Environmental Impact Statement

Gentlemen:

The undersigned are counsel for the Tantalum Producers Association ("TPA") and, in that capacity, represent the interests of member companies which manufacture columbium and tantalum compounds from natural and synthetic ores containing radioactive source material. Ordinarily, the member companies operate with Nuclear Regulatory Commission ("NRC") source material licenses and, thus, have a vested interest in the decommissioning policies of the NRC. Furthermore, the members of TPA are uniquely qualified to assess the environmental impact of the proposed criteria as they relate to the decommissioning of ore processing facilities.

Technical representatives of the member companies of the Association have met to review and discuss the draft generic environmental impact statement ("GEIS") relating to decommissioning of nuclear facilities.* The following comments represent a compendium of inputs from various member companies with respect to the GEIS.

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* NUREG--0586, January, 1981 (Fed. Reg., Vol. 46, pp. 11666-68, February 10, 1981, Notice of availability of GEIS)

CLASSIFICATION OF FUEL CYCLE AND NONFUEL CYCLE FACILITIES AS GENERIC IS INAPPROPRIATE

TPA urges that the NRC consider and assess the impact of its proposed criteria on nonfuel-cycle facilities separate and apart from fuel cycle facilities. Vast differences in the radioactive emission potential, quantities of material to be disposed of, pathways of exposure, financial capabilities and availability of storage sites make it inappropriate to lump fuel cycle and nonfuel-cycle facilities together for purposes of environmental impact analysis. For many of the same reasons, it is inappropriate to lump together nonfuel-cycle facilities such as sealed source manufacturers, radiopharmaceutical manufacturers, R & D facilities and ore processors.

If one considers the fact that ore processing facilities frequently occupy many acres of land, generate hundreds of thousands of cubic feet of contaminated soil, and contaminate huge pieces of equipment and the buildings in which they are located, it should be obvious that the environmental impact of decommissioning one of these facilities will be vastly different than that associated with the decontamination of a power plant or a few laboratory hoods used for the processing of short half-life radioactive substances typically handled by sealed source manufacturers, radiopharmaceutical manufacturers and R & D facilities.

TPA urges that NRC remove ore processing from consideration in the current GEIS and subsequent rulemaking proceedings relating to decommissioning of fuel cycle facilities and that NRC handle future decommissioning of ore processing facilities on a case-by-case basis. Fortunately, this approach will not impose an undue burden on NRC because there are relatively few of these facilities in the country, the shut-down rate is extremely low and case-by-case review will be required in any event. This latter point is developed in greater detail later in this presentation. On the other hand, the difficulty, if not impossibility, of lumping fuel cycle and nonfuel-cycle facilities together for analysis is clearly illustrated. A good example is the setting of appropriate residual radioactivity levels. In the companion documents to the draft GEIS Pacific Northwest Labs ("PNL") talks in terms of establishing a residual radioactivity level in terms of "realistically exposed individuals," which concept includes assumptions with respect to a 40-hour work week, breathing rate, physical location in the work place, etc. In order for valid assumptions to be formulated with respect to ore processors, it would be necessary for a case-by-case analysis to be made. Otherwise, "pathways of exposure" unique to this type of operation would not be identified, and the conclusions based on experience and testing at fuel cycle facilities or other nonfuel-cycle facilities would be inapplicable. This leads TPA to the conclusion that since a case-by-case analysis must be made in order to establish realistic residual radioactive levels, it would not involve much more work to expand this analysis to include decommissioning criteria. In order for realistic decommissioning criteria to be developed for ore processors, factors such as half-life, leaching potential of the sludge, the likelihood of human exposure and the lack of reliable technology to measure radium 226 must be considered. These factors have not and cannot be properly considered in the context of a GEIS.

Another illustration of the problems created by attempting to lump together for analysis dissimilar types of facilities relates to the "sensitivity analyses" for a variety of parameters potentially affecting safety and cost considerations. Purportedly, PNL expanded their facility reports to include such sensitivity analyses. However, TPA has reviewed the PNL report and notes that it does not adequately address the enormous cost of transporting high-volume low-level radioactive waste to disposal sites nor does it address the problem of inspection costs. More importantly, there is no mention of the "sensitivity analyses" in the GEIS.

COMMENTS ON SPECIFIC ITEMS IN THE GEIS

Technical Aspects of Decontamination

NRC has set forth preliminary conclusions with respect to the environmental impact of the decommissioning criteria in the Federal Register notice. While those conclusions may be valid with respect to fuel cycle facilities, it is not demonstrated that they are applicable to the nonfuel-cycle facilities and, particularly, the ore processors. For example, the statement is made that "when properly performed, decommissioning has only minor adverse impact." Paragraph 14.4 on page 14-12 of the GEIS purports to justify this conclusion. TPA submits that the three short paragraphs under paragraph 14.4 represent bare conclusionary statements which are not supported by any factual data whatever.

More specifically, the GEIS contains a statement that machinery used in the processing of radioactive ores "...can be readily decontaminated and surveyed to confirm that radioactivity levels are low enough to allow unrestricted use". The inference is that decontaminating equipment and buildings is simple and inconsequential in calculating the costs of decommissioning an ore processing facility. This is simply not true. For example, much of the equipment used for the processing of columbium-tantalum ores must be rubber lined. Decontamination of this equipment involves separation of the liner from the base metal, disposal of the liner as a low-level radioactive waste, and acid treatment of the bare tank for removal of radioactive material. In addition, sewers, building walls and roofs, pipelines and pumps become contaminated and all of these facilities must be decontaminated or demolished and disposed of as low-level radioactive wastes. The erroneous conclusion reached by NRC with respect to ore processors seems to come about as a result of a misunderstanding of the extraction process. The initial stage mechanical refining machinery can be readily decontaminated. However, subsequent refining processes involve complex chemical extraction procedures which, in turn, introduce contamination in a substantial and pervasive way that is very difficult, if not impossible, to clean up.

Cost Factors

The cost of removal estimate contained in GEIS (page 14-9) is based upon a hypothetical 20,000,000 pounds of sludge. The figure of 2.9 million dollars is low by a factor of up to ten, depending on transportation costs. The only low-level radioactive waste landfill capable of accepting this type of material charges approximately $10.00 per cubic foot for disposal and inspection services alone. When the cost of drying, packaging and transportation are included, a more realistic cost of $0.35 to $1.00 per pound of sludge emerges. This results in disposal costs of $7,000,000 to $20,000,000.

The Department of Energy has estimated costs for decontamination of old uranium processing facilities ("Description of the Formerly Utilized Sites Remedial Action Program", ORO-777, September, 1980). The area used for storage of uranium tailings at the St. Louis, Missouri Airport would cost an estimated $98,000,000 for decontamination. Decontamination of the Middlesex, New Jersey Sampling Plant is estimated to cost $48,000,000. Decontamination of the Feed

Materials Plant operated by Mallinckrodt, Inc. in St. Louis, Missouri is estimated to cost $26,000,000. Decontamination of the Tonawanda, New York site used for disposal of uranium processing residues is estimated to cost up to $9,000,000. These examples are for facilities comparable to ore processing plants, and they demonstrate the magnitude of potential decontamination costs.

Finally, any meaningful cost analysis must consider the potential for recovery of residual rare metals from the tailings. At the present time, recovery of such metals is not economically feasible. However, increasing shortages of world supplies of these metals, combined with domestic inflation, may ultimately make the recovery of such residual rare metals cost effective. This potential argues in favor of SAFSTOR as opposed to DECON as an approach to decommissioning an ore processing facility. The reason is that once the tailings are removed to a permanent landfill, the recovery of residual metals becomes an impossibility.

<u>Disposal Site Capacity</u>

A glaring omission in the GEIS is the failure to consider the availability and capacity of sites that permit disposal of high-volume low-level radioactive waste. Currently, there are three such sites in the United States, but only one, U. S. Ecology at Beatty, Nevada, will accept new commitments for disposal of low-level radioactive waste from outside of the state. In view of the current political climate, it is unlikely that any new low-level high-volume disposal sites will be opened in the near future. That, coupled with the fact that the Beatty Site operators are considering banning additional disposal of ore processing sludges, introduces an entirely new environmental impact consideration which applies solely to the ore processing industry. Until the disposal site location problem is addressed and solved, it is impossible to assess realistically the impact of decommissioning criteria that call for disposal of high-volume low-level radioactive sludges in sites that don't exist now, and won't exist in the foreseeable future.

<u>Transportation Risks</u>

Another factor which has not been considered, but which is relevant to the ore processing situation, is the transportation risk inherent in trucking high volumes of sludges from the processing site to the disposal site. One of the TPA member companies has commissioned a study which has resulted in the conclusion that 1200 truck loads of sludge being transported some 400 miles will result in six accidents. Obviously, increased distances between the disposal site and the processing site would increase the statistical probability of accidents occurring. The potential for such harm suggests that, with respect to ore processors, the SAFSTOR concept should be more seriously considered.

PART 14 -- GEIS

There are several statements contained in Part 14 of GEIS which relate to ore processors and which are incorrect or incomplete. In general, it should be noted that GEIS concentrates on tantalum/columbium ore processors. No apparent consideration was given to other processing operations which must have radwaste problems. Examples would include titanium, copper, lead-zinc and fluorspar.*

A statement is made on page 14-5 of GEIS that the main problem with decommissioning an ore processing facility consists of disposal of the slag or tailings and cleaning up of spills. It is not true that ore processing machinery can be readily decontaminated. As pointed out above, the chemical extraction and processing facilities have pervasive contamination. In many cases decontamination would not be cost effective, which means that entire pieces of equipment and building components would have to be disposed of in a licensed low-level site.

The statement with respect to Kawecki Berylco Industries' method of handling contaminated surface soil is inaccurate. (GEIS page 14-5) The site in question is a licensed burial site utilized for the disposal of glassy slags and not the sludges which are generated by ore processors in such large volumes.

The GEIS (page 14-5) carries a description of the sludge handling at Kawecki Berylco Industries. This is not necessarily typical of the many different ore processing operations in this country.

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* Reference "Radioactivity in Selected Mineral Extraction Industries A Literature Review" U.S. Environmental Protection Agency, U.S. Office of Radiation Programs, Las Vegas, Nevada, PB-290 744, November, 1978.

The GEIS (page 14-5) cites decontamination of Reed Keppler Park in West Chicago, Illinois as an example for consideration in this study. The extensive review of decontamination of the old thorium processing facility in West Chicago is published in the report "Thorium Residuals in West Chicago, Illinois" NUREG/CR-0413. In this report, it appears that Reed Keppler Park was not totally decontaminated, but is being managed as a SAFSTOR site.

The statement is made at the bottom of page 14-10 of the GEIS that "this sludge could be disposed of in a local landfill if it did not exceed an acceptable residual radioactivity dose limit, which has yet to be determined." This statement is misleading for the reason that a licensed facility is prohibited from transferring any waste to an unlicensed landfill. Furthermore, the only method of reducing the radioactive content below .05% is by dilution which is specifically prohibited.

The GEIS (page 14-11) indicates that decontamination of the ore processing sludge by chemical removal of uranium and thorium seems an attractive alternative. Such chemical removal is not cost effective. Further, the chemical removal of uranium and thorium leaves other radionuclides, such as radium 226 which is typically found in ore processing sludges. The members of TPA know of no technology presently available to remove selectively the various radioactive substances from waste sludges.

MISCELLANEOUS MATTERS

We note that the Federal Register notice identifies four policy areas in which present regulatory requirements and guidance are not specific enough. These are Timeliness, Financial Assurance, Planning and Residual Radioactivity Levels. As far as the ore processors are concerned, the GEIS does not address the Planning and Financial Assurance aspects of the proposed criteria.

The decommissioning policy ultimately will have to comply with Executive Order 12291 regarding a cost benefit analysis. Unless additional consideration and better documentation of the real costs of decommissioning in the ore processing industry are added and then compared to the benefits to society, the proposed GEIS will be found wanting in any kind of realistic cost benefit analysis. This, of course, reenforces the previously made point that each ore processor is typified by factors which are unique to its operation and, therefore, any meaningful cost benefit analysis has to be carried out on a case-by-case basis.

Finally, the decommissioning policy considers that it is timely to develop a decommissioning plan when an NRC license is applied for. This planning function, and the financial assurance requirements, together with the extremely low residual contamination level being used for this study, will impose a financial burden on the tantalum/columbium producers of this country that will place them at a severe disadvantage vis-a-vis their foreign competitors.

TPA appreciates this opportunity to comment on the draft GEIS. We trust that these comments will be helpful to NRC in developing a realistic decommissioning policy applicable to the ore processing industry. Please be assured of our continuing interest in this rule-making procedure.

Very truly yours,

BAKER & HOSTETLER

By William W. Falsgraf
William W. Falsgraf

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08379-81-001

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(46 FR 11666)

16

KERR-McGEE CORPORATION

KERR-McGEE CENTER • OKLAHOMA CITY, OKLAHOMA 73125

April 20, 1981

ENVIRONMENT AND HEALTH MANAGEMENT DIVISION

DOCKETED
APR 24 1981

EXPRESS MAIL

Secretary of the Commission
US Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Docketing and Service Branch

RE: Comments on Draft Generic Environmental Impact Statement on Decommissioning Criteria for Nuclear Facilities
Federal Register Vol. 46, No. 11666, February 10, 1981

Gentlemen:

Kerr-McGee Corporation and Kerr-McGee Nuclear Corporation ("Kerr-McGee") submit the following comments in response to the draft generic impact statement on decommissioning of nuclear facilities ("draft EIS"), for which notice of availability was published on February 10, 1981.[1] (See Vol. 46, Federal Register No. 11666.) As indicated by the referenced notice, the draft EIS contains certain conclusions with respect to the decommissioning of nuclear facilities. The notice suggests that the Commission intends to issue a policy statement and proposed regulations implementing these conclusions.

Interest of Kerr-McGee. Kerr-McGee Nuclear Corporation, a subsidiary of Kerr-McGee Corporation, operates a uranium hexafluoride conversion facility and has operated other nuclear facilities including a mixed oxide fuel fabrication plant and uranium fuel fabrication plant. Kerr-McGee Corporation subsidiaries have operated a non-fuel cycle nuclear facility now in the decommissioning process. Kerr-McGee has direct experience

[1] Comments on the draft EIS were originally due on March 23, 1981. The due date was subsequently extended to April 22 because the draft EIS was not in fact available for distribution in a timely fashion. In Kerr-McGee's view, the time afforded by the NRC for review of the draft EIS and for filing comments is inadequate in view of the document's scope. For example, Kerr-McGee has not undertaken analysis of the section of the draft EIS pertaining to uranium fabrication facilities since the facility technology report was not available in a timely fashion.

in operating and in decommissioning facilities covered by the draft EIS. Kerr-McGee and its employees will be effected by actions taken by NRC based in whole or in part upon the draft EIS.

Summary. Kerr-McGee believes that the draft EIS is premature; that it proposes unreasonably stringent standards and criteria for decommissioning; that it fails to analyze legitimate alternatives; that it does not comply with Executive Order 12291; and that it contains numerous erroneous factual assertions and analytical deficiencies. NRC should withdraw the draft EIS pending further study, and the agency should defer action on preparing decommissioning criteria until (1) the Environmental Protection Agency (EPA) has promulgated valid general standards, (2) more information becomes available and inaccuracies in NRC's analysis are corrected, and (3) policies concerning disposal of radioactive waste are finalized.

I. General Objections to Draft EIS

A. The Commission's Draft EIS, Intended Policy Statement, and Intended Regulations Are Premature and Must Be Deferred

Reorganization Plan No. 3 of 1970[2] by its terms transferred to EPA the authority to set generally applicable radiation standards under the Atomic Energy Act of 1954 (See Section 2(a)(6) of the Plan). Assuming the validity of the Reorganization Plan, it is clear that EPA, not NRC, possesses the authority to establish general standards for public exposure to ionizing radiation upon decommissioning.[3] In its draft EIS, NRC proposes to upset this division of responsibility. In particular, NRC proposes to adopt a 10 mrem whole-body equivalent exposure limit for decommissioned sites. This kind of limitation is precisely the type of standard within EPA's province. NRC's attempt to issue its own standards constitutes a blatant usurpation of EPA's responsibility. The draft EIS, which is predicated on the 10 mrem

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[2]35 Federal Register 15623, 84 Stat 2086, 42 U.S.C. Section 4231 note.

[3]NRC admits that EPA is responsible for issuing the pertinent standards. Draft EIS at 0-6 and 15-9.

standard, must accordingly be withdrawn and all NRC action on its conclusions must be deferred pending final promulgation of valid EPA standards.

B. The Draft EIS is Based Upon Unproven and Unreasonable Assumptions and Deficient Analysis

The draft EIS is based upon a variety of unsupported and unreasonable assumptions. These errors, detailed in part below, render it unacceptable as a basis for agency decision-making.

1. Arbitrary Limitation of Possible Exposure to 10 mrem or Less

The draft EIS propounds the hypothesis that human exposure to ionizing radiation at the site of a decommissioned nuclear facility should be limited to 10 mrem/year or less in whole-body equivalent.[4] The agency's explanation for this standard is deficient. The limitation appears to be keyed to NRC's assumption that a risk is acceptable so long as it is about one in a million or less.[5] This level of risk is vanishingly small. It is essentially equivalent to no risk at all. Individuals customarily accept risks much greater than one in a million.[6] The agency's apparent determination that one in a

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[4] *See, e.g.,* draft EIS at vi-vii.

[5] Draft EIS at 2-11

[6] The following table sets forth a number of commonplace and therefore acceptable risks of death:

Cause	Individual risk/year
motor vehicle - Total	1/4,500
(1975) - pedestrian	1/25,000
home accidents (1975)	1/83,000
air travel - one transcontinental flight/yr	1/330,000
accidental poisoning - solids and liquids	1/170,000
accidental poisoning - gases and liquids	1/140,000

(footnote 6 continued...)

million is an acceptable risk is thus far too conservative for decisional purposes.

NRC's 10 mrem standard is unsupportable for another important reason as well. It was evidently selected without any analysis of costs likely to be incurred in achieving it or the risks posed to workers assigned to carry out the stringent decommissioning requirements. NRC must consider the costs to regulated industry and the risks to workers in attaining a 10 mrem standard before that standard may be adopted. These costs and risks are significant and generally exceed any benefit reasonably attributable to meeting the standard in question.[7]

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[6] The following table sets forth a number of commonplace and therefore acceptable risks of death:

Cause	Individual risk/year
inhalation and ingestion of objects	1/71,000
electrocution	1/200,000
falls	1/13,000
air pollution (sulphates)	1/6,700
(benso(a)pyrene)	1/33,000
vaccination for small pox (per occasion)	1/330,000
living for one year downstream of a dam	1/20,000
bicycling	1/100,000
drowning (from recreational activities)	1/53,000
government employment	1/9,100
agricultural employment	1/1,700
truck driving employment	1/2,000
alcohol	1 in 20,000
smoker	1 in 300
person in room with smoker	1 in 100,000
one pint of milk per day (uflatoxin)	1 in 100,000

Source: OSHA Testimony of Professor Richard Wilson reprinted in Hutt. Unresolved Issues in the Conflict Between Individual Freedom and Government Control of Food Safety, 33 FD&C L.J. 558, 564-66 & 568 (1978).

[7] NRC's only generalized discussion of costs in the draft EIS is in the context of an assertion that survey and decontamination costs are essentially the same for a standard in the range of 1 to 25 mrem per year. See, e.g., draft EIS at 0-7. NRC's assertion is erroneous. Kerr-McGee has direct experience in these matters and can attest that the cost in fact increases significantly for dose reduction in the range of concern. For example, there is a cost increase of as much as 10% for each 1% reduction in dose below 25 mrem/year for decommissioning of uranium fuel fabrication facilities.

NRC's 10 mrem standard is also inconsistent with the agency's other regulations pertaining to unrestricted areas. In particular, current regulations prescribe far less stringent limitations on radioactivity in unrestricted areas. See e.g., 10 CFR Section 20.105 (500 mrem limit). See also 25 Federal Register 4402 (May 18, 1960) (radiation protection guidance for Federal agencies). There is no evidence that adherence to these less stringent standards for unrestricted areas has resulted in any health effect to any individual.

The unreasonableness of the 10 mrem standard suggested by NRC is further attested by consideration of the background radiation encountered by all individuals. Average national background radiation (cosmic, terrestrial and internal body radiation) varies from State to State between approximately 90 mrem and 180 mrem average exposure per year. Variation is caused primarily by different altitudes above sea level and by natural rock formations. Living near a granite rock formation, for example, may result in exposure to 25 to 100 mrem additional exposure per year.[8] There is no evidence that this background radiation has had any adverse effect upon the population. Under the circumstances, it is arbitrary and capricious to specify a 10 mrem exposure limitation.

NRC's 10 mrem requirement is also contrary to the agency's own analysis of factors relevant to the establishment of such standards. NRC, for example, states that "selected (exposure) levels for unrestricted facility use must be verifiable through actual detailed survey measurements of the facility and site, and be within reasonable bounds regarding state-of-the-art survey detection methodology and costs".[9] Survey measurement methodology does not exist, and is unlikely to exist in the future, to verify adherence to exposure standards of 10 mrem/year or less. Accordingly, the 10 mrem/year standard is contrary even to the factors NRC identifies as germane to its establishment.

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[8]See Low-Level Ionizing Radiation, Hearings Before the Subcommittees on Energy Research and Production and Natural Resources and environment of the House Committee on Science and Technology, 96th Congress, 1st Session at 8-9 (1979).

[9]Draft EIS at 15-8

2. The Draft EIS Arbitrarily Provides that Decommissioned Facilities Must be Available for Unrestricted Use

The draft EIS arbitrarily subscribes to the concept that decommissioned facilities must be availabe for unrestricted use.[10] NRC's arbitrary assumption that unrestricted access to the site of a nuclear facility is the appropriate regulatory approach is unreasonable for a number of reasons. For example, NRC's approach:

a) removes incentives from industry to develop cost-effective alternatives;
b) stagnates the research effort in effective design of waste control systems; and
c) provides unreasonable criteria for existing sites to meet.

NRC's approach is also contrary to alternatives endorsed by Congress in the mill tailings area. In that area, government ownership of tailings disposal sites is envisioned. Moreover, as already indicated, reduction of residual radioactivity to levels below 10 mrem/year is not required to release a facility to unrestricted use.

3. NRC's Draft EIS Conflicts with Executive Order 12291 and Policy of the Administration

Section 2 of Executive Order 12291, Federal Register 13193 (February 17, 1981), directs Federal agencies to adhere to the following requirements:

"a) Administrative decisions shall be based on adequate information concerning the need for and consequences of proposed government action;

"b) Regulatory action shall not be undertaken unless the potential benefits to society for the regulation outweigh the potential costs to society;

[10] See e.g., draft EIS at vii and O-2. The agency suggests, without evidence, that such decommissioning has "major beneficial impact." The agency also asserts that the land in question constitutes "valuable individual land." There is no evidence of the benefical impact or the economic attractiveness which NRC claims.

"c) Regulatory objectives shall be chosen to maximize net benefits to society;

"d) Among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; and

"e) Agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefits to society, taking into account the condition of the particular industries affected by regulations, the condition of the national economy, and other regulatory actions contemplated for the future."

The draft EIS and NRC's proposed actions based thereon fail to comply with the terms of this Order. As the previous sections have demonstrated, the draft EIS is bereft of adequate information supporting the conclusions reached in that document. The draft EIS is likewise lacking of any evidence of serious cost-benefit or cost-effectiveness analysis by NRC of the conclusions which it advocates. Indeed, little or no effort is made in the draft EIS to weigh benefits and costs.[11]

The draft EIS additionally is devoid of any discussion of the adverse impact on the already troubled nuclear industry which compliance with the EIS conclusions would entail. The EIS also lacks any consideration of the effect of the proposals upon the national economy. The EIS thus fails to recognize that the NRC actions advocated in the documents would push the nation toward further dependence on unreliable imported petroleum as a fuel source. Any actions by the agency based upon the draft EIS quite clearly would not comply with the Executive Order.

[11] The draft EIS in fact indicates that NRC intends completely to ignore ~~cost-~~benefit analysis for levels of exposure greater than the arbitrary 10 mrem/year level. Cost-benefit, according to NRC, will only figure in decisions to permit exposure in excess of 1 mrem/year up to the 10 mrem level. <u>See</u> Draft EIS at O-7. This abbreviated use of cost-benefit analysis is flatly contrary to Executive Order 12291. Under that Order, the agency must justify <u>any</u> standards it proposes on the basis of an analysis of their cost and benefits.

C. The Draft EIS Misconceives Its Appropriate Role

A generic EIS should identify "common" considerations in facility decommissioning. Rather than discussing common considerations, the draft generic EIS is devoted to vindication of a 10 mrem standard, to an effort at establishing site-specific reclamation criteria, and to an unduly abbreviated analyses of decommissioning alternatives for each faciity type. This is improper use of a generic EIS. Such a document is supposed to analyze the environmental consequences of proposed agency decisions and to evaluate alternatives. It is not intended for use as an adversarial support document or apology for specific agency positions. It is certainly improper to employ a generic EIS to treat detailed concerns relating to a multiplicity of highly differentiated nuclear facilities.

II. Objections to Specific Assertions Contained in the Draft EIS

A. NRC's Analysis Concerning Financial Assurance is Deficient

The draft EIS argues that NRC must impose financial surety requirements to "provide a high degree of assurance" that adequate funds are available for decommissioning. The draft EIS also suggests that self-insurance is not an adequate surety for decommissioning performance. Other regulatory schemes impose surety requirements permitting self-insurance. CEG 33 CFR, Section 135.213 ("off-shore"). There is no evidence that self-insurance is less suitable for the nuclear industry in comparison to other industries where self-insurance is permitted.

NRC is in error in assuming that it has authority to impose financial surety requirements. The only surety authority enjoyed by NRC is with respect to decommissioning of uranium mills. 42 U.S.C. Section 2210(x). That authority was specifically conferred by Congress in Section 203 of the Uranium Mill Tailings Radiation Control Act (UMTRC Act) of 1978. That specific provision would be mere surplusage if, as NRC now contends, the agency has all along possessed general authority to require sureties. It is elementary that a statute should not be interpreted so as to render any of its provisions a nullity.

See, e.g., United States vs. Menasche, 346 U.S. 528, 538-39 (1955); Aparacor, Inc. vs. United States, 571 F.2d 552, 557 (Ct. Cl. 1978); Kenneth vs. Schmoll, 482 F.2d 90, 94 (10th Circuit 1972); Tabor vs. Ullos, 323 F.2d 823, 824 (9th Circuit 1963). Accordingly, NRC's sudden discovery of purported general authority to impose surety requirements must be rejected.

Even if NRC possessed general authority to impose surety requirements upon its licensees, such authority may not properly be exercised on the basis of existing information. There is no evidence in the draft EIS that any licensee has in fact ever defaulted in carrying out any pertinent decommissioning requirement. The record in fact indicates that no surety requirements are necessary in order to provide the requisite degree of assurance that decommissioning will take place as required. NRC, for example, repeatedly emphasizes that decommissioning expenses are far less than other uninsured expenses incurred by licensees.[12] Under such circumstances, it would be illogical to require a surety. NRC also presumably analyzes the financial ability of its licensees to comply with relevant requirements when the agency issues or renews their licenses. Indeed, this kind of analysis is expressly required by NRC's regulations in some instances. The Commission presumably would not issue or renew a license if a licensee were not prepared and able to carry out decommissioning requirements. The agency's regular monitoring of the capability of its licensees via the licensing process provides sufficient assurance of the ability of its licensees to meet decommissioning criteria.

Assuming *arguendo* that the NRC could lawfully impose some additional surety requirements, the agency's formulation of those requirements in the draft EIS is unsupported. For example, the agency suggests that licensees could obtain "decommissioning insurance" or "surety bonds." There is no evidence that such financial instruments would be available. Indeed, it is Kerr-McGee's belief that such instruments would *not* be available for many decommissioning activities at a reasonable cost and may not be availabe at all, at any price.

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[12] See Draft EIS at 247.

NRC's rejection of self-insurance alternatives is also arbitrary and unsupported. Many of the agency's licensees are large, financially sound corporations, such as public utilities and energy companies. These licensees are at least as financially sound and stable as the bonding companies, insurance companies, and banks which would be the sources of the surety which NRC seeks to require. It is simply an unnecessary tie-up of working capital and an unwarranted subsidy to the banking and insurance industries to require operators of nuclear facilities to purchase surety bonds or insurance from outside organizations.

Finally, financial assurance mechanisms should not be applicable to facilities currently undergoing decommissioning. There is no evidence that assurance is required for decommissiioning which is presently underway. Imposing surety requirements in such cases will simply increase costs and tie up liquid assets required for the decommissioning.

If, contrary to the above, NRC does proceed to attempt to impose surety requirements, the agency should limit itself to requiring creation of a reserve (e.g., sinking fund) based upon the production rate of the salable commodity (e.g., UF_6, fuel pellets, electric power) to be generated gradually throughout the active life of the facility. Any other approach will impose an unfair burden upon current customers of services rendered by the nuclear industry and result in market dislocation and inefficient allocation of resources.

B. The NRC's Reliance on Low-Level Waste Disposal Facilities is Improper

Throughout the draft EIS, reference is made to the alleged necessity of removal of contaminated buildings, equipment, and so forth to low-level waste burial sites. However, the availability and conditions for use of such disposal facilities are open to substantial question. Existing low-level waste disposal facilities are reaching capacity or may in any event soon be closed to most generators of low-level waste. Congress has recently enacted legislation calling for States to enter into interstate compacts to provide such facilities, but it is too early to form any view as to the success of this legislation in the creation of additional disposal facilities. Moreover, NRC has not yet published even proposed regulations for such facilities. Given all these uncertainties, it is clearly improper for NRC to assume that low-level waste disposal facilities will be available on reasonable terms for decommissioning purposes. It is far more realistic to view on-site, low-level waste disposal as the most likely and most reasonably available method for decommissioning. In addition, it is clearly the more practical and cost-effective method for decommissioning facilities since it reduces, among other things, transportation and handling costs and worker exposure. The criteria which NRC is considering for low-level waste burial will clearly be highly germane to the decommissioning effort. Kerr-McGee cannot fully address low-level waste disposal until NRC issues appropriate regulations and discloses the basis for requirements contained in those regulations.

C. NRC Arbitrarily Imposes a One Hundred Year Limit on Safe Storage or Entombment

The draft EIS indicates that the agency foresees only three methods for achieving the purported end of unrestricted use of decommissioned facilities: (a) immediate decontamination, (b) safe storage, or (c) entombment. NRC arbitrarily imposes an upper limit of 100 years on the period during which safe storage or entombment may be employed. No justification is provided by NRC for the 100 year period on institutional controls for radioactivity confinement.[13] Indeed, no time frame should be prescribed for any safe storage or entombment period because:

1) the specific characteristics of the safe storage site and waste characteristics may justify an indefinite safe storage period;

[13] NRC rather obscurely implies that the 100 year figure may represent the longest period during which a human structure may be relied upon to exist. See Draft EIS at 0-6. However, NRC requires the contrary in its mill tailings regulations which are predicated upon assuring that tailings structures survive for much longer periods.

2) arbitrary removal of a safe storage facility at the end of a 100 year period may be unjustified from a health and safety standpoint; and

3) NRC must examine available alternatives on a site-by-site basis.

D. Application of Proposed Requirements to Existing Facilities

The draft EIS is deficient in failing to identify and to consider the special factors relevant to the operation and abandonment of nuclear facilities commissioned prior to any decommissioning requirements adopted by NRC as a consequence of the draft EIS. There are numerous such factors. For example, it may be difficult if not impossible for the owner or operator of an existing facility to pass on any of the increased costs attributable to new decommissioning requirements on account of long-term contracts or market conditions. This problem is magnified because existing facilities may not have been designed in a fashion such that they can readily be brought into compliance with stringent decommissioning criteria which new facilities may be designed readily to meet. On the other hand, assuming that increased costs attributable to decommissioning can be passed in part to customers of the facility in question, it is nevertheless inequitable to require such customers to pay for increased decommissioning costs attributable in part to the provision of services to former customers. In short, numerous reasons exist to apply less stringent criteria to existing facilities, and NRC's draft EIS (and proposed actions) should be modified accordingly.

E. NRC's Analysis of Decommissioning Uranium Hexafluoride Conversion Plants is Deficient

Kerr-McGee Nuclear Corporation operates the Sequoyah UF_6 conversion plant located in Sequoyah County, Oklahoma. This is one of the two currently operating commercial conversion facilities in the United States. The data on decommissioning conversion plants is limited. The draft EIS states that it will soon be supplemented with a detailed technical report on decommissioning of UF_6 plants, scheduled for issuance in 1982. The adoption of any criteria or standards relating to UF_6 plant decommissioning would be premature prior to issuance and public review of this UF_6 decommissioning document. Moreover, Kerr-McGee's experience indicates that decommissioning of a UF_6 plant must be based upon evaluation of detailed site specific characteristics which cannot be covered in a generic EIS. Because of the lack of information covering plant decommissioning, the expected issuance of a pertinent report, and the site-specific nature of such decommissioning, UF_6 plants should be excluded from the scope of the draft EIS. In any event, the existing analysis in the EIS is fraught with deficiencies and further NRC action should be deferred pending their correction. Some of these deficiencies are detailed below.

1. Uranium Hexafluoride Conversion Plant Decommissioning Experience (Paragraph 10.2, Page 10-2)

Paragraph 10.2 states that the AEC plant located in Weldon Springs, Missouri is a UF_6 conversion plant currently undergoing decommissioning. The Weldon Springs plant did not convert yellowcake to UF_6. Its final product was uranium metal only, with no intermediate production of UF_6. Experience in the decommissioning of that plant is therefore of questionable value for purposes of extrapolation to actual UF_6 conversion plants.

2. Decon (Paragraph 10.3.1, Page 10-4)

Paragraph 10.3.1 hypothesizes that non-salvagable hard-to-decontaminate equipment and all contaminated materials will be shipped to and disposed of in a low-level waste burial ground. As Kerr-McGee has earlier noted, low-level waste disposal facilities may not be available upon reasonable terms. On-site, low-level waste burial should be clearly identified as the more viable and cost-effective option for UF_6 plant decommissioning.

3. Site Decommissioning (Paragraph 10.3.4, Page 10-6)

The draft EIS indicates that material buried on-site must be removed to a low-level burial ground and that "the removal of onsite buried material is expected to be a minor effort compared to the rest of the decommissioning." These statements are completely without foundation. The estimated quantity of contaminated material resulting from decommissioning of the Kerr-McGee Nuclear Sequoyah UF_6 facility is 295,000 cubic feet. Moreover, material buried on-site at that facility amounts to 7.5 million cubic feet (providing current amendments are granted).[14] Removal of quantities of these magnitudes to low-level waste disposal facilities is not justifiable. Removal will not only be unduly costly but will add unnecessary environmental problems due to the disturbance of stabilized sites. Moreover, any such removal is directly contrary to license provisions specifically providing for disposal by burial. The statements made in the draft EIS concerning removal of this material are arbitrary and capricious and without foundation in fact.

4. Waste Disposal (Paragraph 10.4.2, Page 10-7)

The draft EIS estimates volume of low-level waste to be 570 cubic meters (20,127 cubic feet) for a conversion facility. Contrary to the estimate in the draft EIS, there will be an estimated 295,000 cubic feet of contaminated material from the decommissioning of the Kerr-McGee Nuclear Sequoyah facility alone, even without consideration of the 7.5 million cubic feet of material buried on the premises. Thus, one of the five facilities at issue in the analysis will alone have from 15 to almost 400 times the amount of material projected by NRC upon decommissioning.

Given these figures, it is simply not credible for NRC to predicate an analysis of decommissioning of conversion facilities on the assumption that such disposal would involve such a small amount of material.

F. The Analysis of the Draft EIS Pertaining to Non-Fuel Cycle Nuclear Facilities is Deficient

The draft EIS covers a diversity of non-fuel cycle facilities and operations. Little information is availabe on many of these

[14] This information is contained in NRC's own records.

activities. This problem may be somewhat alleviated when the expected technical report on non-fuel cycle nuclear facilities is issued. In view of the lack of information, Kerr-McGee believes that it is premature for NRC to issue policy guidance or proposed regulations at least until detailed public review of the referenced technical report has been accomplished. Kerr-McGee has several specific comments concerning the draft EIS insofar as it pertains to non-fuel cycle nuclear facilities, and specifically to ore processors.

1. Ore Processors (Paragraph 14.1.3, Page 14-3)

The draft EIS states that there is currently no satisfactory place to ship tailings produced by ore processors for disposal. Kerr-McGee agrees with the statement insofar as it suggests that such shipments is presently out of the question. However, the statement may be read to imply that shipment of tailings from such facilities is an alternative if disposal facilities become available in the future. Any such suggestion is unsupportable. Shipment of large volumes of tailings material for any distance is prohibitive on a cost-benefit/cost-effectiveness basis. Moreover, it would raise contamination risks and possible levels of worker exposure. It would be the least viable alternative for decommissioning of ore processing sites.

2. Decommissioning Alternatives for Processors of Radioactive Ore (Paragraph 14.3.3, Page 14-9)

The draft EIS indicates that NRC is considering only two decommissioning alternatives for ore wastes; removal (DECON), and neutralization and stabilization for long-term care. The draft EIS states in paragraph 14.3.3.2. Neutralization and Stabilization (page 14-11), that neutralization and stabilization may not be viable over the long-term and would have to be considered on a case-by-case basis. This statement is erroneous to the extent that it is intended to suggest that shipment of tailings to a low-level waste disposal facility is the preferred disposal alternative. As Kerr-McGee has noted, shipment of large volumes of tailings material for any distance is the least viable alternative for decommissioning ore processing facilities. The NRC should proceed with great caution in devising decommissioning requirements for ore-processors. The discussion in the draft EIS is based solely on a limited analysis of a single ore-processing operation involving the extraction of columbium and tantalum. Other ore-processing operations which may be covered by future NRC action predicated on the draft EIS may exhibit totally different conditions.

G. The Draft EIS Analysis of Decommissioning Small Mixed Oxide (MOX) Fuel Fabrication Plants is Inadequate

The draft EIS analysis of MOX plants is purportedly based upon a study by Pacific Northwest Laboratories of Kerr-McGee's Cimarron facility. The study contains many inaccuracies. These deficiencies have been discussed in separate comments made by Kerr-McGee on the Pacific Northwest study (see attached copy). The analysis of MOX plants in the draft EIS is deficient and not a suitable basis for decisionmaking for reasons similar to those noted by Kerr-McGee in the referenced comments.

Conclusion

The draft EIS fails to set forth or consider pertinent information on the costs and benefits of pertinent decommissioning alternatives and criteria. Moreover, it utterly fails to engage in any reasoned comparison or balance of the costs versus the benefits. The draft EIS substitutes assumptions for analysis and in so doing fails to identify many options and totally obfuscates the basis for critical conclusions reached in the document (*e.g.*, the 10 mrem/year exposure standard and the requirement that a decommissioned facility be available for unrestricted use). The draft EIS sweeps too broadly by: (a) attempting to encompass so many divergent nuclear facilities, (b) purporting to establish standards properly within the province of EPA, and (c) seeking to devise what essentially are site-specific criteria. The draft EIS should be withdrawn. All NRC actions intended to be based on the draft EIS should be deferred.

Kerr-McGee recommends that NRC base its docommissioning criteria upon a case-by-case analysis of the facilities in question and apply traditional ALARA principles in arriving at decommissioning requirements.

Very truly yours,

W. J. Shelley

W. J. Shelley, Vice President
Nuclear Licensing & Regulation

WJS/hmw

KERR-McGEE NUCLEAR CORPORATION
KERR-McGEE CENTER • OKLAHOMA CITY, OKLAHOMA 73125

October 12, 1978

CERTIFIED - RETURN RECEIPT REQUESTED

Mr. C. E. Jenkins
Senior Research Engineer
Engineering Evaluations
Safety and Environmental Analysis Section
Battelle Northwest Laboratories
Battelle Boulevard
Richland, Washington 99352

Dear Mr. Jenkins:

Please refer to your letter of August 21, 1978 transmitting the working draft report of the study of decontamination of an MOX Fuel Facility.

As we discussed in a phone conversation on September 5, Kerr-McGee has certain reservations as to some of the proposed activities, release calculations and assumptions. The data adopted by Battelle has resulted in a set of data that is extremely conservative and demonstrates excessive releases and exposures. It is Kerr-McGee's position that these releases and exposures will be at least a factor of 10 less than those projected. In the case of your report, perhaps this result is intended as a matter of NRC policy. In Kerr-McGee's private operation, we do not believe it demonstrates the true results of such a decontamination.

We have attached a list of specific comments referenced by page which, it is our understanding, you will consider in the revision to your finished document.

Thank you for the opportunity to review this report.

Very truly yours,

W. J. Shelley

W. J. Shelley, Director
Regulation and Control

WJS:ml

Attachment

Volume I

p. 2-2 The 10 mCi/gram limit for shallow land burial of plutonium is not an internationally accepted value and is excessively restrictive. The NRC has recognised this problem and has published notice (F.R. August 18, 1978, pp 36722-36725) proposing that a concentration limit within a shallow land burial site be 100 nanocuries per cubic centimeter of plutonium waste and that the maximum concentration within an individual container could be a factor of 10 higher.

We feel that the 10 nCi/gram limit you have used should be changed to 1 microCi/cubic centimeter per packages containing plutonium waste materials destined for shallow land burial.

p. 9-4 Electropolishing is not needed to meet reasonable burial limits. Electropolishing should only be considered as an alternative to regular chemical or physical cleaning methods. Its value, on a small scale, whould be for cleaning items such as tools and instruments with high salvage value, for ultimate unconditional release. Electropolishing generates a quantity of contaminated liquid which must be subsequently treated in S.X. and I.X. systems or evaporated and cemented for burial. The extra handling of contaminated materials while electropolishing will likely cause unnecessary contamination spread and employee exposures.

p. 8-12 Plowing the acreage around the plant is entirely unnecessary at the Cimarron Facility. A realistic above background limit from soil samples should be used to determine the need for plowing the land.

p. 9-4 Packing of equipment parts etc., leaves ample space for bagged wipes, plastic and paper scrap. The wipes etc., are needed as cushioning material in the packages. A special incinerator for reducing the volume of combustible waste is of dubious value and will add to the dust load carried by the air effluent filtration system. An extra fire hazard potential always exists when operating incineration equipment.

p. 2-11 Kerr-McGee does not plan to demolish its plant. We believe that it can be refurbished for unrestricted use. Removal of four inches of concrete from wall surfaces will not be needed in most areas.

p. 7-3 The factor of (10^{-9} x 2 MTHM/yr = releases) is high by an order of magnitude for the Cimarron Facility which had a maximum throughput near half MTHM/yr.

p. 10-5 For Cimarron, the listing of manpower is excessive. Many of the job positions listed can be handled by one person.

p. 2-18 Shows 206 man years required for immediate dismantlement and Volume II, Table H.2-1 shows 81.1 man years.

p. 9-9 Reference to reactor should be removed.

Volume II

p. A-10 Ultrasonic washing of pellets was not used.

p. A-11 X-ray machine is used to inspect for rod loading specifications as well as end cap weld.

p. A-14 A-15 Hot laundry batch tank 6,000 gallon size and sanitary waste batch tank 10,000 gallon size.

p. A-43 The main electrical distribution panel and distilled water treatment system is in the supply fan room instead of in the mechanical room.

p. A-58 Sanitary lagoons are not lined with PVC liners.

Table 11.1-1

In reference to the 4500 μci release level for the plasma arc cutting, a double filter transmission factor of 2.5×10^{-7} should be used in their calculations instead of the single filter transmission factor used to arrive at the values in Table 11.1-1.

(17)

DOCKET NUMBER
PROPOSED RULE PR-30, 40, 50, 70, 72
(46 FR 11666)

DANIEL D. HESSLIN
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SAVINGS BANK BUILDING
MANISTEE, MICHIGAN 49660
TELEPHONE PARKVIEW 3-3322

APR 24 1981

emp

April 21, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Docketing and Service Branch

Re: Docket No. NUREG0586

Gentlemen:

Attached for filing in the captioned docket is an original and five photo-copies of "Comments of Wolverine Electric Cooperative, Inc."

Yours very truly,

Daniel D. Hesslin

Daniel D. Hesslin

DDH: jm
Enclosures (6)

(17)

PR-30, 40, 50, 70, 72
(46 FR 11666)

DOCKETED
APR 24 1981
Secretary

UNITED STATES OF AMERICA

BEFORE THE NUCLEAR REGULATORY COMMISSION

Decommissioning criteria for)
Nuclear Facilities)

Docket No. NUREG-0586

COMMENTS OF
WOLVERINE ELECTRIC COOPERATIVE, INC.

1. Wolverine Electric Cooperative, Inc., (hereinafter called "Wolverine") is a non-profit cooperative supplying electric generation and transmission service to its four member/owned cooperatives, at wholesale, within Wolverine's service area in parts of twenty counties being Allegan, Barry, Clinton, Eaton, Gratiot, Ionia, Isabella, Kent, Lake, Manistee, Mason, Mecosta, Missaukee, Montcalm, Muskegon, Newaygo, Oceana, Osceola, Ottawa and Wexford, being approximately the central one-third of Michigan's Lower Peninsula, and maintains its principal office at 302 S. Warren Avenue, Big Rapids, Michigan 49307.

2. Wolverine is solely owned by Oceana Electric Cooperative, Hart, Michigan 49420; O & A Electric Cooperative, Newaygo, Michigan 49337; Tri-County Electric Cooperative, Portland, Michigan; and, Western Michigan Electric Cooperative, Scottville, Michigan, which have executed all-requirements contract with Wolverine.

3. Wolverine is a public utility regulated in the State of Michigan by the Michigan Public Service Commission.

4. Wolverine has an undivided ownership interest, as a tenant in common, of 8.78% of the Enrico Fermi Nuclear Unit No. 2, presently under construction in Frenchtown Township, Monroe County, Michigan, and by reason of such ownership is an intervenor in Case No. U-6150 entitled "In the Matter of the Establishment and Treatment of Nuclear Plan Decommissioning Funds" now pending as a generic hearing before the Michigan Public Service Commission.

5. Wolverine has an interest in this proceedings in as much as it may be bound by the adoption of a proposal regarding the establishment and funding of decommissioning funds and as a result of federal regulations.

6. Wolverine is not regulated by the Federal Government in that all of its transactions are intrastate subject to those regulations adopted by the Rural Electrification Administration in that Wolverine is a 100% debt financed cooperative regulated by the Rural Electrification Act and whose funding of long-term obligations is totally financed by the United States Government acting through the Administrator of the Rural Electrification Administration.

7. Wolverine, as a non-profit cooperative owned by its members, has two primary purposes which would be to pay for all costs associated with decommissioning, and also to pay for costs associated with a nuclear accident not covered by insurance.

8. Cooperative philosophy and funding is very different from the objectives of an invester owned utility. Where an investor owned utility properly seeks to maximize revenue and profit, a cooperative being a not for profit corporation seeks to minimize expense. Revenue and expense to a cooperative are merely additions or deletions to member owned equity.

9. Wolverine agrees the public health and safety is paramount and further agrees there should be reasonable assurance of the availability of funds upon decommissioning. Wolverine insists that its cooperative obligations are to maximize interest earned by any fund after meeting its public obligations as any surplus from sums so ear-marked and collected from its members should be for the member/owner's benefit. Wolverine would oppose any effort by government to gain control of the member equity as confiscatory since Wolverine is of the sound conviction that government can only maximize expense----not income. Wolverine proposes that any decommissioning costs or funds would be deposited in a "sinking fund" controlled by the Board of Directors of Wolverine and said funds would be placed in an account subject to the approval of the Rural Electrification Administration. Wolverine assumes that the "sinking fund" will consists of Treasury Bills, Treasury Bonds and other evidences of indebtedness purchased by Wolverine from the United States Government. That part of rates established by MPSC, which would be in addition to present rates paid by the cooperative member/owners, and should be periodically scrutinized by MPSC and adjusted up or down as experience would dictate.

10. Wolverine would not propose to invest any portion of decommissioning or insurance funds collected as a part of rates in additions to its electric plant. Wolverine believes the fund must be internally controlled as it and its members are convinced Wolverine's proposal will ensure the public need for assurance concerning the availability of funds upon decommissioning, and will also ensure that our member/owners pay the smallest amount necessary consistent with the need to protect the public including our own members and that costs can best be controlled when managed by the cooperative itself.

WOLVERINE ELECTRIC COOPERATIVE, INC.
John N. Keen, Manager

By: Daniel D. Hesslin
Daniel D. Hesslin, Attorney for
Wolverine Electric Cooperative, Inc.

CC: All parties of Record
MPSC Case No. U-6150

(18)

Mallinckrodt, Inc.

PR-30,40,50,70,72
(46 FR 11666)

675 BROWN RD • P O BOX 5840 • ST LOUIS, MO 63134 • (314) 895-0123

DOCKETED
APR 24 1981

April 21, 1981

Secretary of Commission
United States Nuclear
Regulatory Commission
Washington, D.C. 20555

Re: Decommissioning Criteria for Nuclear Facilities; Comments Concerning Draft Generic Environmental Impact Statement

Gentlemen:

On February 10, 1981 the U.S. Nuclear Regulatory Commission (NRC) invited advice and comments on "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities", NUREG-0586, January, 1981 (Federal Register, Volume 46, pp. 11666-11668, February 10, 1981). Mallinckrodt, Inc. manufactures columbium and tantalum compounds at its St. Louis, Missouri plant, under an NRC source material license. Mallinckrodt thus has a vested interest in the generic environmental impact statement and in regulations related to the decommissioning of licensed facilities.

Mallinckrodt is also a member of the Tantalum Producers Association (TPA) and has contributed to the development of comments on the GEIS. Those comments were filed April 21, 1981 by William W. Falsgraf, Esquire. The comments reflect Mallinckrodt's judgements regarding the GEIS and the decommissioning rules now being considered by NRC, and Mallinckrodt would like to go on record in support of those comments.

Sincerely,

S N Robinson

S. N. Robinson,
Director, Environmental Affairs

/bd

(19)

DOCKET NUMBER
PROPOSED RULE PR-30, 40, 50, 70, 72
(46FR 11666)

STATE OF MICHIGAN
DEPARTMENT OF ATTORNEY GENERAL

STANLEY D. STEINBORN
Chief Assistant Attorney General

FRANK J. KELLEY
ATTORNEY GENERAL

LANSING
48913

April 20, 1981

APR 24 1981

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Washington, D.C. 20555

RE Michigan Public Service Commission Staff's Response to the Draft Generic Environmental Impact Statement. NUREG-0586

Dear Sirs:

The Staff of the Michigan Public Service Commission welcomes the opportunity to comment on the Draft Generic Environmental Impact Statement. On October 16, 1979, the Michigan Public Service Commission instituted proceedings regarding the establishment and treatment of nuclear plant decommissioning funds for Michigan utilities. Its order instituting proceedings defined four issues to be addressed:

1. Which methods of funding are most equitable and least expensive for Michigan ratepayers.

2. The tax implications of the various funding methods.

3. The financial effects of the various funding methods of the companies' operating nuclear facilities.

4. The legal requirements necessary to ensure the availability of funds collected at the time of decommissioning.

Consumer groups, industrial consumers, utilities, and the Staff have testified on these issues in public hearings. Briefs are to be submitted by the parties on June 15, 1981. I have enclosed the following documents which comprise the Michigan Public Service Commission Staff's comments on the Draft Environmental Impact Statement:

Attachment I - Summary of Commission Staff's position

Attachment II - Staff's filed testimony

Attachment III - Transcript excerpts which further define the Staff's position

The Staff will inform you of the Michigan Public Service Commission's order and findings on nuclear decommissioning funding when they are issued.

Sincerely,

Arthur E. D'Hondt
Don L. Keskey
S. David Kutinsky
Assistant Attorneys General
and
Counsel for Commission Staff

1000 Long Boulevard, Suite 11
Lansing, Michigan 48910
Telephone: (517) 373-7584

SDK/rg
enclosures
cc: Joseph Barden, MPSC

SUMMARY OF STAFF'S POSITION

I. Using the present value of revenue requirements and the rate of growth of revenue requirements year-to-year as the criteria, an unfunded reserve method appears to be the best balance between least expensive and most equitable for the ratepayer.* The tax cost associated with the annual provision is deferred (page 28)**.

II. If funded reserve method annual provisions were tax deductible, and the unfunded reserve method annual provisions were not, the funded reserve would strike the best balance between least expensive and most equitable for the ratepayer (page 29)

III. The Staff would not recommend the extension of normalization accounting where recurring tax timing differences are involved, but would support normalization for non-recurring tax timing differences (page 30). We view the provision for decommissioning of nuclear power plants as non-recurring due to the infrequent addition of such plants to Michigan utility systems and the uncertainty as to how many and when such units might be added in the future.

IV. Desirable legal safeguards for all funding methods are that; (1) the utility and its successors who own a particular nuclear power plant have the legal obligation to effectively decommission that plant and pay for the costs incurred to do so; (2) the obligation under (1) runs with the ownership of the plant and must be discharged regardless of what technique is used to provide the required funds; (3) the obligation to decommission and pay for the cost of decommissioning is not limited to customer provided funds or funds held in trust; (4) the obligation to pay for the cost of decommissioning will have a prior claim on the assets of the owning institution, prior even to outstanding obligations to pay taxes, creditors, employees or any other person having a claim against such assets; (5) provisions for decommissioning of nuclear power plants shall be reviewed at least every four years by the Michigan Public Service Commission with respect to sufficiency, fairness and relative security by way of public hearing; and (6) provisions shall be identified as to which nuclear power plant they pertain and provisions shall not be comingled regardless of method used to make such provisions. Trust funds established pursuant to either the funded reserve method or the initially funded method shall require that; (1) any amounts held in trust pursuant to funding decommissioning can only be used for that purpose and will be provided to the owning institution only upon receipt by the trustee of a statement of expenditures made or to be made to decommission a particular nuclear power plant; (2) any trust fund shall be deposited with a trustee and shall be held as irrevocable (page 37).

V. Because the utility itself is entrusted with the funds from an unfunded reserve, additional safeguards appear to be needed. They are that; (1) any unfunded reserves established to provide for the decommissioning of nuclear power plants cannot at the end of any fiscal year exceed 10% of the net electric utility plant in service as recorded pursuant to the net original cost accounting concept; (2) any amounts in such unfunded reserves in excess of the 10% limit outlined in (1) shall be funded and transferred to a trust fund; (3) unfunded reserves shall have

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prior claim on the assets of an institution owning a nuclear power plant; and (4) any unfunded reserve reflected on the balance sheet of a utility, which owns a nuclear power plant, shall become the obligation of subsequent owners of the plant. The same obligations shall exist for the successor owner as existed for the previous owners. And finally, in the event any owner of a nuclear power plant appears to be having difficulty raising capital and the situation appears to so warrant, the Commission through its security issuance oversight authority, shall require the utility to initially fund the decommissioning cost inflated to reflect the cost of decommissioning the plant at the time the decision is made. (Fund earnings will keep the amounts intact from that point on.) (page 38)

Also enclosed is additional testimony by Staff Witness Barden on:

1. When should utilities begin providing funds for decommissioning. Transcript p. 437-438.

2. Tax deductibility of contributions to funds. Transcript p. 471-473.

3. Risks associated with various funding methods. Transcript p. 613-622.

This document paid for with State funds.

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* Most equitable for the ratepayer: Contributions to the fund as between the several generations of ratepayers over the life of the fund are most fairly shared.

** Page references refer to Staff testimony of Joseph C. Barden.

GENERAL ELECTRIC

NUCLEAR POWER

SYSTEMS DIVISION

GENERAL ELECTRIC COMPANY, 175 CURTNER AVE., SAN JOSE, CALIFORNIA 95125
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MFN 078-81

20

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(46 FR 11666)

Docketed
USNRC
MAY 5 1981
Office of the Sec.
Docketing & Ser.
Branch

April 17, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Docketing and Service Branch

Gentlemen:

SUBJECT: COMMENTS ON DRAFT GENERIC ENVIRONMENTAL STATEMENT; DECOMMISSIONING CRITERIA FOR NUCLEAR FACILITIES (46FR11666-68)

References:

1) NUREG-0586, Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, USNRC, January 1981
2) R. I. Smith, et al, Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130, Volumes 1 and 2, Prepared by Pacific Northwest Laboratory for USNRC, June 1978
3) H. D. Oak, et al, Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station, NUREG/CR-0672, Volumes 1 and 2, Prepared by Pacific Northwest Laboratory for USNRC, June 1980

These comments by the General Electric Company are in response to the notice on the above subject in The Federal Register of February 10, 1981, inviting comments on Reference (1). Our principal concern is that decommissioning cost bases for various types of power stations are not fully consistent and therefore unnecessarily penalize the Boiling Water Reactor (BWR).

We have reviewed the studies (References 2 and 3) on decommissioning of PWR and BWR plants and note significant differences in costs which appear to be unjustified. Page 0-45 of Reference (1) states that DECON (immediate dismantlement) costs are \$33.3 million for a PWR and \$43.6 million for a BWR. We direct your attention to portions of Pages 12-11 and 12-12 of Reference (3) (copy attached). The Pacific Northwest Laboratory authors state that the PWR (Reference 2) and the BWR (Reference 3) studies used different bases for permissible radiation dose, and that the staff labor costs for BWR dismantlement would be reduced about \$7 million if the basis used in the BWR study had been the same as that used in the PWR study. Since a 25% contingency has been applied in both studies, this $7 million unwarranted difference is actually about $8.8 million. We find no mention of this discrepancy in Reference 1.

Under another category of "Special Tools and Equipment" we find costs of $0.8 million for the PWR (Reference 2) and $2.0 million for the BWR (Reference 3). It is not apparent from the studies that any portion of this $1.2 million difference is justified. With the 25% contingency this difference magnifies to $1.5 million. Other differences may be due to the BWR and PWR studies being done at different times. For example, we note licensing fees of $51,000 for the BWR but none for the PWR.

These differences in evaluation bases appear to account for the major portion of the BWR/PWR cost differences in the Draft Statement. Any residual variations would appear to be well within the uncertainty band of such estimates. While these comments apply to the DECON method, we believe they would also apply in slightly varying amounts to the SAFSTOR (safe storage followed by ultimate DECON) and to the ENTOMB (encase in strong structure) decommissioning methods.

We request that the authors of the Draft Generic Environmental Impact Statement review References (2) and (3) and correct Reference (1) by removing significant inequities and differences in evaluation bases.

Requests for further information or specific questions on BWR decommissioning may be referred to Mr. R. H. Buchholz, (408) 925-5722, Manager, BWR Systems Licensing.

Very truly yours,

G. G. Sherwood

G. G. Sherwood, Manager
Nuclear Safety and Licensing Operation

GGS:lm/1378-79

Attachment

cc: L. S. Gifford (Washington Liaison)

ATTACHMENT 1

Inequitable PWR/BWR Permissible Dose Bases Used for Decommissioning Cost Studies

The following two paragraphs are quoted directly from NUREG/CR-0672, Volume 1, at Pages 12-11 and 12-12:

"In the PWR study, it was assumed that all of the decommissioning workers could receive radiation doses of up to 3 rem per quarter. No attempt was made on a task-by-task basis to adjust the staff size or manpower loadings if the average radiation dose to the hands-on workers did not exceed 3 rem per quarter.

In this BWR study, however, it is assumed that the supervisors, utility operators, and health physics technicians are long-time radiation workers whose annual exposure is limited to 5 rem per year by the formula 5(N-18) given in 10 CFR 20.101(b)(2). The craftsmen and the laborers are assumed to have had little previous radiation exposure and can receive radiation doses of up to 3 rem per quarter (within the constraint of the 5(N-18) formula). As a result, manpower requirements for this BWR study are estimated not only on the basis of the number of workers needed to physically accomplish the work, but also on the basis of providing enough workers to assure compliance with the assumed radiation dose limits outlined above. This analysis basis necessitates the employment of a significantly larger work force for dismantlement of the BWR than would have been the case under the straight 3-rem-per-quarter basis assumed for the PWR study. It is estimated that the staff labor costs for dismantlement of the reference BWR would be reduced by about $7 million if all of the workers were permitted to receive a radiation dose of up to 3 rem per quarter."

GGS:lm/1380
4/14/81

NOTE: Telecopied to 202-634-3319 4/22/81.

John D. O'Toole
Vice President

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(21)

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April 22, 1981

Docketed USNRC
5 1981
Office of the Sec. Docketing & Ser. Branch

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Dear Sir:

On February 10, 1981 a Notice of Avaiability of the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586 was published (46 FR 11666) and comments were invited from interested parties. On March 5, 1981, the comment period for NUREG-0586 was extended to April 22, 1981. Consolidated Edison Company of New York submits herewith its comments on the draft EIS. Con Edison is the licensee of Indian Point Unit No.2 located at Buchanan, New York. Also located at the Buchanan site is another reactor owned by the Power Authority of the State of New York, which is known as Indian Point Unit No.3.

Comments:

1. The Statement does not address decommissioning of a multiple (two to four units) nuclear site. The conclusions reached for a single unit, in our opinion, would not necessarily be valid for a multiple unit site like Indian Point. We understand that an NRC study on decommissioning of multiple unit sites is underway. We suggest the present draft EIS carefully note that:

    a) the conclusions on decommissioning alternatives for a multiple unit site may differ from those stated; and

    b) a study for multiple unit sites is underway and that the report on its findings will be noticed for comments.

    In particular, we believe that any comprehensive approach to multiple unit decommissioning must recognize that portions of one retired unit may be used in support of other operating units at the site, or as redundant safety systems, and that there may accordingly be an appropriate regulatory basis under certain circumstances for deferring dismantlement.

2. The conversion of a nuclear plant to a new or modified (nuclear or fossil) facility, after it has ended its useful life is a viable alternative to decommissioning, and should be acknowledged in the draft EIS. Dismantlement and removal of major components/structures of a plant to accommodate new or modified facilities would in our opinion be a form of decommissioning. The statement, however, does not address this scenario.

3. Con Edison supports the sinking fund approach outlined in Section 2.6.2 of the draft report. We believe that the certainty of having funds available at the time of decommissioning is important and should outweigh any small differential in cost to ratepayers over the depreciation method. Under the depreciation method a significant amount of the decommissioning funds to be spent must be funded from reduced federal income tax payments at the time of such expenditures. The certainty of such funds being available is clouded by the possibility that a utility may be in a tax loss and tax carry-forward position at that time. Therefore, further tax deductions at the time of actual decommissioning might only increase the tax carry-forward and not provide the necessary funds for decommissioning.

   Con Edison strongly believes that one change to the funding approach would significantly improve the economics from the point of view of revenues required of electric utility customers. As an alternative to establishing a sinking fund managed by a utility, the responsibility for managing the funds could be placed with a public agency. If a regulatory commission or other governmental agency would set up a trust or fund for these monies which such agency would control and administer, it is likely that the earnings of such a trust -- unlike a privately administered one -- would not be taxable. Under such circumstances no income tax liability would be imposed on the trust earnings, and the full benefit of earnings on the trust would go towards funding the decommissioning, thus reducing the amount to be funded by the electric utility customer.

   A publicly administered trust fund would in all probability reduce the cost below the cost under a depreciation type approach to decommissioning funding and at the same time assure that the necessary funds would be available when the decommissioning actually takes place.

4. With regard to the concept of coupling a funding approach with decommissioning insurance which would protect a company against the risk of a premature closing of a nuclear generating facility by providing the costs of decommissioning, it is our understanding that such insurance is not now available. If such insurance protection becomes available at reasonable cost, Con Edison would support the concept assuming, of course, that such insurance is deemed a proper expense for ratemaking purposes by our regulatory commission.

5. We strongly disagree with the prepayment alternative outlined in Section 2.6.2. Prepayment of decommissioning cost would place an unnecessary financial burden on the utility at a time when it can least afford it. The utility industry is already experiencing serious difficulties in raising capital without trying to raise additional funds for retiring a facility 30-40 years hence.

We appreciate this opportunity to submit comments on the proposed EIS.

Yours truly,

John D. O'Toole
Vice President

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(22)

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April 23, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Dear Sir:

We have discovered a typographical error in our earlier comments of April 22 regarding the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, which affects the substance of our comments. We are therefore submitting the enclosed corrected version to be substituted for our earlier submittal.

Your cooperation in this matter is greatly appreciated.

Very truly yours,

Vice President

kb
Enc.

Commonwealth Edison
One First National Plaza, Chicago, Illinois
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Chicago, Illinois 60690

April 23, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Docketing and Service Branch

Dear Sir:

Commonwealth Edison Company ("Commonwealth") submits these comments on the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, and the associated Staff papers, noticed in the Federal Register on February 10, 1981 46 Fed. Reg. 11666. Commonwealth has licenses to operate seven nuclear units, including the nation's oldest commercially built nuclear reactor, Dresden 1, and holds construction permits for six more units at La Salle County, Byron and Braidwood. Accordingly, Commonwealth has a strong interest in the establishment of practicable guidance for the decommissioning of nuclear facilities.

Commonwealth Edison is in general agreement with the comments of the Utility Decommissioning Group and the Atomic Industrial Forum. We hope that the NRC will give their comments serious consideration.

Commonwealth Edison views with special concern the conclusion of the Draft Generic Environmental Impact Statement that additional mechanisms are required to provide "a high degree of assurance" that adequate funds are available for decommissioning. In the first place, with the exception of accident situations, Commonwealth does not agree that shut-down nuclear facilities present any significant risk to the public, and therefore there is no need for a "high degree of assurance" that large amounts of capital be immediately available for decommissioning. This is certainly implicit in the acceptability of the SAFSTOR option, which contemplates segregating the facility from the public while residual radioactivity undergoes natural decay. The appropriate standard is whether there exists a "reasonable degree of assurance" that decommissioning funds will be available when needed, taking into account the safety significance of decommissioning.

Moreover, as the NRC Staff paper on "Financing Strategies for Nuclear Power Plant Decommissioning," NUREG/CR-1481, makes clear, there is a significant cost advantage to the present internal reserve system over other funding mechanisms considered, such as prepayment or segregated sinking funds. We believe this cost advantage is important, particularly in light of the serious difficulty many utilities are currently experiencing in raising funds in the capital markets. Because licensees' ability to raise capital to meet NRC requirements is limited, first priority has to go to those matters which provide the greatest improvement in safety. Again, it seems obvious that the application of funds to building and operating reactors in the safest possible manner is more in the public interest, than, for example, diverting such funds to segregated reserve accounts which would secure only remote and marginal safety improvements.

Commonwealth Edison recognizes that the accident at Three Mile Island points to the need for additional funds for clean-up of similarly damaged facilities, although clearly there may be companies for which the impact of a premature decommissioning would be tolerable financially without external financial support. The Draft Generic Environmental Impact Statement and the accompanying Federal Register notice do not explicitly state whether the NRC intends to propose rules governing financial assurance for decommissioning costs prior to completion of the further studies on post-accident decommissioning referred to therein. In our view, the financial and technical requirements of post-accident decommissioning should be treated separately from those of normal decommissioning. However, if the NRC does intend to publish rules addressing post-accident decommissioning in the near future, we urge that it adopt the most flexible possible approach to requiring additional financial assurance mechanisms. Unnecessarily prescriptive NRC requirements specifying insurance as the only practical measure for meeting decommissioning obligations could raise serious questions as to the availability of appropriate insurance coverage. We therefore would encourage use of regulatory guides or other non-binding guidance in this area, if the NRC believes additional financial assurance for accident-related decommissioning is required.

Secretary of the Commission
U.S. Nuclear Regulatory Commission
April 23, 1981
Page Three

With respect to the technical issues presented by the Draft Generic Environmental Impact Statement, Commonwealth has no objection to the proposal that decommissioning plans be developed for each operating plant, subject to two important qualifications. The planning requirement should be phased in such a way that it does not delay the issuance of new operating licenses. Second, the planning should not be so detailed that it fails to allow for significant advances in decommissioning technology during the 30-year life of the facility. Commonwealth believes it would be reasonable to update these general decommissioning plans no more frequently than every five years. Such updating should not be the occasion for public hearings. Either the plan itself should not be part of the operating license, or (assuming the Sholly decision is corrected) it should be established by the Commission, when the decommissioning requirements are first adopted, that such updating does not involve significant hazard considerations.

Commonwealth does not agree that post-decommissioning residual radioactivity levels in excess of 1 mrem/year would require justification. A more appropriate threshold for regulatory attention would be 5 mrem/year. And, of course, the level of residual radioactivity deemed to be acceptable would depend on the proposed use of the decommissioned site. In referring to land dedicated for SAFSTOR and ENTOMB operations, the Draft Generic Environmental Impact Statement seems to imply that the entire site would be restricted until all significant radioactive materials are removed. In reality only a very small portion of the land area originally covered by plant buildings would need to be restricted.

Finally, while Commonwealth recognizes that the Draft Generic Environmental Impact Statement expressly excludes recommissioning from consideration, we wish to emphasize that in light of the inherent quality and safety of nuclear facilities, the most reasonable alternative at the end of a nuclear power plant's operating license could well be allowing continued operation rather than decommissioning the facility.

Commonwealth Edison appreciates the opportunity to submit comments on this NRC document.

Respectfully submitted,

Vice President

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23

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April 22, 1981

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Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Docketing and Service Branch

Re: Decommissioning Criteria for Nuclear Facilities; Draft Generic Environmental Impact Statement

On Tuesday, February 10, 1981 the Nuclear Regulatory Commission published in the Federal Register (FR 11666) a Notice of Availability of the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, dated January, 1981. This Federal Register Notice invited comments from interested persons and indicated that the comments must be received on or before March 23, 1981. On Thursday, March 5, 1981 the NRC published in the Federal Register (FR 15278) a Notice of the Extension of the Comment Period on the Draft Generic Environmental Impact Statement to April 22, 1981.

The Atomic Industrial Forum Subcommittee on Decommissioning has been active in providing input to the NRC Staff in the Development of new rules which may be promulgated for the decommissioning of nuclear facilities. On November 28, 1979 members of the AIF Subcommittee met with representatives of the Commission Staff and others to discuss the Subcommittee's position on decommissioning. Various members of the Subcommittee have also commented separately to the NRC Staff on the NUREG documents which have been published as a result of the NRC's re-evaluation of policy on the Decommissioning of Nuclear Facilities.

The AIF Subcommittee carefully reviewed the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities and prepared the attached comments. It is our hope that these comments will add a broader perspective to the final eneric Impact Statement on decommissioning of nuclear facilities. The AIF Subcommittee is also aware of the work being done by the Utility Decommissioning Group and because of this awareness and knowledge generally endorses the comments of that group.

The Atomic Industrial Forum and particularly the members of the Decommissioning Subcommittee are available at any time to meet with the Commission Staff to discuss the comments attached to this letter and look forward to that opportunity.

Yours very truly,

W. J. L. Kennedy

W. J. L. Kennedy
Chairman, AIF Committee on Environment

WJLK:pl

cc: G. D. Calkins
Decommissioning Program Manager
Division of Engineering Standards
Office of Standard Development
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATOMIC INDUSTRIAL FORUM
SUBCOMMITTEE ON DECOMMISSIONING
COMMENTS ON NUREG-0586

DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT
ON DECOMMISSIONING OF NUCLEAR FACILITIES

On February 10, 1981 the Nuclear Regulatory Commission published for comment NUREG-0586, Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (DGEIS). This DGEIS has been prepared as a part of the re-evaluation of NRC policy on decommissioning of nuclear facilities and will serve as a basis for potential rulemaking in the area of decommissioning policy. The AIF Decommissioning Subcommittee has reviewed the document in detail and has general and specific comments Also, the Subcommittee's efforts have been limited thus far to the decommissioning of nuclear power plants.

GENERAL COMMENTS

The NRC staff appears to be placing undue emphasis on the need to develop more specific regulatory guidance for decommissioning. The reason for this is not clearly stated but evidence of this emphasis is reflected throughout the entire draft statement. From a technical viewpoint, the Subcommittee believes current rules and regulations are adequate for the nuclear industry today The decommissioning of nuclear facilities following premature closure also appears to receive special attention in the DGEIS. The Subcommittee believes the present rulemaking should focus on the question of routine decommissioning and the subject of premature closure considered in a separate effort. Premature closure for reasons other than accidents should be included in such an action.

The Subcommittee is well aware that the costs associated with decommissioning are highly site dependent and is in agreement that generalized cost information determined by the NRC will be useful to utilities in obtaining an adequate rate basis for the decommissioning of facilities. Because of this the Subcommittee believes that the DGEIS should more adequately address the "no action" option with regard to decommissioning re-evaluations. The Subcommittee is of the opinion that it would be in the best interest of the nuclear industry to refrain from developing proscriptive rules and regulations when flexibility is the necessary ingredient from both financial and technical standpoints for the future decommissioning of power reactors.

Ongoing rulemakings or actions in the area of occupational radiation protection standards, _de minimis_ radiation levels, transportation of nuclear waste, _disposal_ of nuclear waste, and power plant siting partially control and impact upon the re-evaluation of decommissioning policies. These factors should be addressed in the DGEIS.

The NRC Staff appears to be committed to the fact that facilities must be ultimately dismantled in order to be decommissioned. The Decommissioning Subcommittee believes that it would be appropriate for the NRC to evaluate entombment and determine the possibility of leaving power reactors in place as a decommissioning mode. Permanent entombment may result in lower costs, lower occupational radiation doses, and minimum impact on the environment compared with other alternatives if adopted. The Subcommittee recognizes that the in-place entombment option would necessitate license changes and the licensing of sites as ultimate disposal facilities. It is not apparent from the DGEIS that such an alternative has been considered.

Another alternative to decommissioning which was not evaluated in the DGEIS, was the option of re-licensing and reuse of the facility. The Subcommittee recognizes that ultimately any power plant at any site must be decommissioned. However, the Subcommittee is of the opinion that the continued use or reuse of existing power reactors can be an environmentally and economically acceptable technical alternative to mothballing, entombment, or dismantling and should be considered.

Current regulations and indeed the DGEIS reflect a variety of alternatives which could be used in the decommissioning of a power reactor. It is unfortunate that the Staff has written the DGEIS in such a way as to imply that the immediate dismantlement or dismantlement after 30 years of mothballing are the recommended options. Alternate assumptions for decommissioning, economic impact on consumers, and ultimate residual radioactivity levels will help to dictate the method of decommissioning most appropriate for power reactors. The method that is selected for one reactor will not necessarily be the best method for all. Again flexibility is essential and the Staff should not limit its conclusions to one or two specific cases as the best methods for decommissioning.

It is the view of the Subcommittee that the costs presented in the DGEIS need to be put into proper perspective so that they can be used to assist utility commissions and utilities in rate regulatory matters. The costs as presented indicate a degree of precision that does not exist in the cost estimates and that do not exist with respect to other utility facilities. A very specific disclaimer or qualification statement needs to be added to the DGEIS to clarify these cost estimates. In addition the DGEIS addresses multiple unit sites from the standpoint of a ten-unit nuclear energy center. However, multiple unit plants of 2, 3, and 4 units are common in the United States and will be more common in the foreseeable future. It is the opinion of the Subcommittee that the DGEIS does not present or justify the costs, timing and scheduling of decommissioning of multiple unit sites consisting of 2, 3, and 4 unit stations and such information would be of greater benefit at this time than data on nuclear energy centers.

The Staff has indicated in the DGEIS that there may be potential problems associated with delaying the dismantlement of nuclear power reactors and yet these potential problems are never addressed. It is the view of the Subcommittee that if studies can support the existance of potential problems that might delay dismantlement, these should be addressed in the DGEIS. Otherwise, such unsupported statements should be removed in the final report.

Protection of the public health and safety does not require de minimus levels of residual radioactivity after the release of property for unrestricted use. While a standard has not been developed for release for unrestricted use, the Subcommittee believes that it is inappropriate for the Staff to consider the extreme possibility of having a multi-family housing development constructed at a current power reactor site. Sites for power reactors were selected based on remoteness from population centers, seismology, geology, hydrology, and meteorological conditions. These same conditions, primarily demography, provide the exact reasons why a housing development would not likely be located on a plant site. Indeed many utilities have indicated a desire to maintain nuclear plant property for years to come. This property could be used as the location for future plants, as the location for major switching stations, or as the location for other utility activities. The Subcommittee believes that a reasonable and appropriate level of residual radioactivity consistent with the existing Regulatory Guide 1.86 or some level based on the standard deviation of all naturally occurring radioactivity is an appropriate degree of public health and safety to which the NRC should set its goals. The determination at the end of plant life of residual radioactivity levels should be on a case by case basis and be provided for through flexibility in both the DGEIS and in new rules stemming from the re-evaluation.

SPECIFIC COMMENTS

Specific comments on the DGEIS are in many ways redundant with the general concerns but do focus the Staff's attention on those areas where revisions should be made in the final Generic Environmental Impact Statement.

Page iii, Paragraph 1

The first sentence of this paragraph indicates an overriding concern of the NRC Staff on the ability of reactor licensees to decommission commercial nuclear facilities following premature closure. The Subcommittee believes that decommissioning of a prematurely closed nuclear power facility should be the topic of a separate rulemaking and should consider all the reasons for such premature shut-down, not just the accident scenario.

Page v, Paragraph 4

The NRC Staff has indicated in Paragraph 4 its opinion that decommissioning can be accomplished safely and at modest cost shortly after cessation of facility operation. The words "shortly after cessation of facility operation" indicate the undue emphasis of the NRC Staff on the immediate dismantlement decommissioning option. Further, the NRC Staff indicates that a delay in decommissioning would require justification since the amount of reduction in occupational radiation dose is of marginal significance. This statement is not supported in the remainder of the report.

Page v, Paragraph 5

The NRC Staff has indicated that there is a similarity between the financial assurance issues for accident and routine decommissioning. The Subcommittee does not believe that such is the case. Since it appears that an undecommissioned, retired plant poses fewer problems of the type described in the report than an operating plant sustaining an accident, the DGEIS conclusion of an urgent need for decommissioning appears to be unfounded. Owners of power reactors will make economic decisions which may dictate prompt decommissioning. The development of financial assurance requirements which would require the availability of money for the full cost of decommissioning at any time during facility operation is unreasonable.

Page vi, Paragraph 1

Seeking a high degree of "assurance" is inconsistent with the Atomic Energy Act as interpreted by the courts and the Commission itself. A standard of reasonable assurance is one that can be met practically and economically by the utility industry. A high degree of assurance that virtually guarantees the availability of funds immediately upon the commissioning of a unit could force the utility industry to abandon the nuclear option altogether.

Page vi, Paragraph 2

An application to operate or construct a nuclear generating facility should be limited to that information required to show that the applicant possesses or has reasonable assurance of obtaining the funds necessary to pay the costs of permanently shutting down the facility and maintaining it in a safe condition. Since the health and safety of the public necessarily include economic impact on the public, the stated de-emphasis of economics in the re-evaluation of decommissioning should be reconsidered and a thorough review of alternatives for the usefulness of the nuclear facility in the future included as a part of the planning.

Page vi, Paragraph 3

The discussion of residual radioactivity levels fails to address release criteria for recycled materials. In addition, the residual radioactivity levels which are addressed are inappropriate. As previously indicated, the Subcommittee believes that a residual radioactivity level consistent with some portion of existing onsite natural background radiation would be an appropriate level which could be justified for release of the property Detailed comments on this subject were provided to the NRC Staff by the Subcommittee on September 15, 1980. A copy of these comments is attached to this document.

Page O-1, Paragraph 2

The NRC Staff indicates that the issue of decommissioning is now receiving an increasing amount of attention because a number of nuclear facilities are nearing the end of their useful lives. This statement is misleading and should be modified. While it is true that research and demonstration reactors have been decommissioned and some older smaller commercial nuclear facilities are currently out of operation there is not a large number of nuclear facilities now nearing the end of their useful lives. In this connection, the Subcommittee believes that the detailed re-evaluation is premature.

Page O-1, Paragraph 3

While we recognize that the Environmental Impact Statement is to assist the NRC in developing new policies, we also recognize that this DGEIS fails to consider the numerous alternatives to the dismantlement of a power reactor. The Subcommittee believes that NRC should include additional alternatives with those addressed in the DGEIS. These alternatives should include re-licensing and reuse of an existing facility, re-certification of existing equipment and permanent entombment.

Page O-1, Paragraph 4

The DGEIS indicates that decommissioning as a result of premature closure may involve technical and cost considerations not yet completely evaluated. As previously indicated, the Subcommittee believes that decommissioning due to a premature closure should be the topic of a separate rulemaking.

Page O-2, Paragraph 4

The Subcommittee does not believe it is necessary or cost beneficial to return the power plant site to a condition permitting unrestricted use at the cost of de minimus levels. Rather, the goal of the re-evaluation should be the protection of the health and safety of the public.

Page O-2, Paragraph 5

The Subcommittee is in agreement with the NRC Staff that the responsibility for decommissioning a commercial nuclear facility belongs to the licensee and that regulatory and policy guidance is the responsibility of NRC. As such, the NRC can provide a valuable service by evaluating and recommending a variety of decommissioning alternatives which could then be effectively used by licensees. It is inappropriate for the NRC to develop rules and regulations which dictate the mode of decommissioning and the method for assuring the availability of funds required to decommission nuclear power facilities.

Page O-4, Paragraph 3

The definition of decommissioning in Sections 0.2.3 and 0.2.4 are not consistent. In Paragraph 0.2.3 decommissioning is defined as meaning "to safely remove the property from radioactive service and to dispose of radioactive materials". Section 0.2.4 indicates through the use of ambiguous terms that entombment is a potential decommissioning alternative. These two definitions are inconsistent and require a thorough evaluation by the NRC Staff as to their appropriateness.

Page 0-4, Paragraph 3

As previously indicated, Section 0.2.4 on Decommissioning Alternatives does not discuss viable alternatives such as re-licensing and reuse and permanent emtombment. The NRC Staff should address these alternatives, and if they are not to be included, indicate the rationale for their elimination. The discussion presented in this section does not adequately provide the basis for a rule on these alternatives.

The NRC has changed its nomenclature with regard to decommissioning so that it is ambiguous. The Subcommittee recommends that the NRC Staff return to the previous nomenclature which has been successfully used and understood by both the Commission and the nuclear industry. Indeed it may be appropriate for the NRC Staff at this time to adopt a terminology which would adequately reflect the wide variety of decommissioning alternatives available for the different types of licensees. An appropriate solution would be the adoption of the existing decommissioning terminology for power reactors and alternate terminology for other licenses.

Page 0-6, Paragraph 3

The DGEIS indicates that existing NRC and EPA regulations dealing with the subject of decommissioning are not specific enough. The Subcommittee questions the need for specificity and to whom they would be directed. As previously indicated, it is the Subcommittee's opinion that existing regulations are adequate.

Page 0-6, Paragraph 5

The NRC Staff indicates that acceptable residual radioactivity levels are needed by NRC for use in the decommissioning program re-evaluation. Rather than adopt a 10 millrem per year activity level, it would be more acceptable for the NRC Staff to utilize a fraction of the background radioactivity level. In addition, acceptable residual radioactivity levels for health and safety reasons and/or for certain uses may be entirely different from those required for unrestricted use. The compatability of these items should be determined.

Page 0-7, Paragraph 1

The NRC Staff clearly indicates that the 10 millrem per year limiting value for residual radioactivity in the DGEIS may be impractical and unnecessary because of cost benefit considerations and problems in detectability, sampling, and/or exposure patterns. With this discussion in mind, it is difficult to understand the need to promulgate new regulations concerning residual radioactivity levels at this time. Furthermore, the DGEIS indicates that decontamination costs for a facility are essentially independent of the level to which it must be decontaminated so long as that level is within the range of 1-25 millrem per year to an exposed individual. The Subcommittee does not believe that the Staff should attempt a rulemaking on such an uncertain basis and urges the Staff to reconsider its position.

Page 0-8, Paragraph 1

The Subcommittee believes it is inappropriate for the NRC Staff to require a high degree of assurance, closely approximating an absolute guarantee, that adequate funds would be available for the premature closure and decommissioning of power reactors. Such an objective has not been justified by the NRC Staff.

Page 0-8, Paragraph 4

The Subcommittee disagrees with the NRC conclusion that whatever NRC-approved funding mechanism is utilized will have a minor impact on the public and the industry. While it may be true that the cost of decommissioning is much smaller than the cost of building or operating a plant, it is still a large amount of money which must be considered in the overall economic analysis and represent funds that could be used more beneficially in other areas.

Page 0-8, Paragraph 6

The Subcommittee recognizes the constraints which the NRC Staff are under in addressing the management of radioactive waste and its interim storage. However, we do believe that the Staff should devote some attention to the discussion of the current availability of burial sites for low level radioactive waste. Obviously, the Staff has considered that waste burial facilities will be available. While members of the Decommissioning Subcommittee also make the assumption that burial facilities will be available it is recommended that the Staff address the current limitations on burial facilities in the DGEIS.

Page 0-9, Paragraph 5

The Decommissioning Subcommittee recommends that the NRC not describe the tertiary loop as such but instead consider the term, "condenser cooling water system." It is important to note that not all power reactors utilize cooling towers for condenser cooling water waste heat disipation.

Page 0-10, Paragraph 4

The dollar estimates indicated in this paragraph are in error when compared to previously published reports and should be explained.

Page 0-11, Paragraph 2

This paragraph would lead one to conclude that permanent entombment of a PWR is a practical alternative limited to the containment building and that other structures must be dismantled or decontaminated. The Subcommittee recommends that the NRC revise its nomenclature because of the ambiguities that can result.

Page 0-13, Paragraph 1

The NRC Staff indicates future changes in technical requirements after a long entombment period might result in additional costly decommissioning activities. The Subcommittee also believes that the regulatory uncertainties of today, with the NRC Staff trying to develop specific guidelines and rules, are causing major unrest in the utility industry. The Subcommittee suggests that the decommissioning re-evaluation develop more appropriate, flexible guidance rather than unyielding specific rules.

Page 0-38, Paragraph 5

The desired objective of protecting public health and safety must be consistent with other NRC rules and regulations. The desired objective should not be to restrict power reactor licensees to unreasonable residual radioactivity levels rather than to levels that would be consistent with the protection of the public health and safety. These two objectives should be integrated in the Final Generic Environmental Impact Statement and in any forthcoming rule.

Page 0-39, Paragraph 8

The NRC Staff indicates that even at a modest cost DECON would be considered the most preferrable alternative for power reactor decommissioning. Again, the Subcommittee emphasizes that a specific selection or even the indication of the selection of a best alternative is inappropriate for the NRC.

Page 0-40, Paragraph 1

The timing, need, and mode for decommissioning power reactors should be considered on a case by case need rather than promulgated by rule. Each site will be different and will have to be handled accordingly to account for plant and site differences.

Page 0-44

The Subcommittee has carefully reviewed the various NUREG documents associated with the decommissioning re-evaluation. We understand that Tables 0.0-1 and 0.0-2 are taken from other NUREGs prepared under contract for the NRC. The cost and dose estimates contained in the tables in NUREG-0586 are different than those contained in the supporting NUREGs previously published (CR-0130 & CR-0672) without explanation.

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Howard J. Larson
Vice President

September 15, 1980

Mr. G. D. Calkins
Decommissioning Program Manager
Office of Standards Development
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Decommissioning Reevaluation

Dear Mr. Calkins:

As indicated in our letter of February 22, 1980 concerning the subject reevaluation, the AIF Subcommittee on Decommissioning has continued its review of several pertinent NUREG documents. This letter provides general comments on the draft NUREG-0613, "Residual Radioactivity Limits for Decommissioning."

As indicated in the draft NUREG, residual contamination may be in or on structures, equipment, components, and soils. An acceptable residual level for any form of contamination will not be a simply set, predetermined value. Even if such an acceptable value could be established, it is not known if it would provide for a de minimus dose. At the same time, the goal of returning a site to the public for unrestricted use after the cessation of operations is not a simply set, definable goal. In many cases the utility which operates a power reactor may have plans for the reactor site which would not require extremely low residual activity levels in order to be acceptable. The NUREG also clearly points out that whatever limits are finally established must be effectively monitored to demonstrate compliance. With these general goals and ideas in mind, the subcommittee has attempted to comment on the NUREG as it now exists.

The title of the draft NUREG is somewhat misleading. Limits on the amount of reactor-originating radioactivity are not given in the NUREG. An exposure standard must be established before the residual radioactivity limits can be established, and the 5 mrem/year suggested in the NUREG may not be practicable.

The draft NUREG specifically addresses power reactors. The reason is stated on page 2 where it indicates that each type of facility may require separate consideration. Indeed, we believe that each reactor site may require separate consideration so that a utility's planned use of the site can be incorporated into the regulatory review.

The NUREG lacks an authoritative definition of a de minimus dose but does not acknowledge that it may be premature to establish residual activity limits for decommissioning. The two are inseparable and any attempt to improve on Regulatory Guide 1.86 without defining de minimus is futile and possibly counterproductive.

The draft suggests that 5 mrem/year to an individual can be considered as the exposure standard for unrestricted use. We believe that this exposure standard is inappropriate since it cannot be measured for enforcement purposes and does not differentiate among sites at various locations around the United States. We recommend that consideration be given to the approach for an exposure standard used by Adler and Weinberg*. Their one standard deviation from natural background provides a realistic base for an exposure standard and one that is measurable. Another important paper in the area of contamination limits for the release of material from decommissioning activities for reuse is "Criteria for Admissible Residual Activity" by Madame Anne Marie Chapuis presented at the November 1978 IAEA Symposium in Vienna. The paper develops a cost-benefit rationale for such limits that should be of value in developing more realistic and appropriate dose bases for contamination limits.

The draft indicates that realistic pathway conditions must be considered. If realistic pathways are indeed to be considered, then site-to-site differences will occur and restrictive standards are impractical. While we agree with the use of a realistic pathway, we suggest that a specification of direct radiation limits above background is the most realistic way to establish residual radioactivity limits which can be monitored and controlled.

*Adler, Howard I. and Weinberg, Alvin M., "An Approach to Setting Radiation Standards", Health Physics, Vol. 34, pp. 719-720, Pergamon Press Ltd., Great Britain, June 1978.

The draft indicates that residual activity levels would be established for a plant site at a fixed, given exposure limit. It would be most difficult to establish whether or not a decommissioned site is meeting exposure limits unless detailed background radioactivity levels were established prior to the start of construction of a given plant. We believe that this is an important consideration that should be addressed in revised drafts of the NUREG.

Regulatory Guide 1.86 is acknowledged in the draft. However, no indication is given as to any particular deficiencies in the existing Regulatory Guide. Since the external radiation pathway is indicated to be the primary pathway, we believe that Regulatory Guide 1.86 is applicable and provides acceptable criteria for surface contamination levels at decommissioned sites.

The draft NUREG indicates that Oak Ridge National Laboratory is developing monitoring programs for decommissioned sites. We hope that this program will take into account the practical considerations associated with detection limits, exposure pathways, and ultimate use of the utility's property. We would appreciate the opportunity to comment on the program being developed at Oak Ridge.

There are important criteria which need to be developed by NRC that could have a significant impact on the decommissioning of a nuclear facility in addition to limits for unrestricted use of materials. Among the most critical is the subject of a radioactive waste classification system which is important to all phases of the nuclear fuel cycle.

The draft NUREG raises many questions concerning the residual radioactivity limits for the decommissioning of light water reactors. We recognize that history is limited, and therefore experience is limited, with decommissioning. We do believe, however, that the Subcommittee will have detailed comments which can be offered in support of the NRC's reevaluation, and suggest that there be an opportunity for an exchange of ideas in the near future.

Sincerely,

Howard J. Larson

HJL:hmh

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LAW OFFICES OF
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DOCKET NUMBER PROPOSED RULE PR-30, 40, 50, 70, 72 (46 FR 11666)

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April 22, 1981

Docketed USNRC 1981 Office of the Sec. Docketing & Ser. Branch

Secretary of the Commission
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Subject: Draft GEIS on Decommissioning of Nuclear Facilities (NUREG-0586)

Dear Mr. Secretary:

I. BACKGROUND

On February 10, 1981, the NRC announced the availability of the "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities" (NUREG-0586) ("Draft GEIS") and solicited written comments and suggestions on it from interested members of the public (46 Fed. Reg. 11666). On March 5, 1981, the NRC extended the deadline for the comment period to April 22, 1981 (46 Fed. Reg. 15278).

On behalf of the Utility Decommissioning Group, 1/ we submit the following comments. All utility members of the

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1/ The Group consists of the Edison Electric Institute and the following 16 power reactor licensees: Arkansas Power & Light Company, Carolina Power & Light Company, Dallas Power & Light Company, Duke Power Company, Jersey Central Power & Light Company, Metropolitan Edison Company, Northeast Utilities Service Company, Pacific Gas & Electric Company, Pennsylvania Electric Company, South Carolina Electric & Gas Company, Southern California Edison Company, Texas Electric Service Company, Texas Power & Light Company, Texas Utilities Generating Company, Virginia Electric & Power Company and Yankee Atomic Electric Company.

Group are NRC licensees which are constructing and/or operating nuclear power reactors. Accordingly, the Group is most interested in, and its comments are directed toward, matters of power reactor decommissioning.

Issuance of the Draft GEIS is the first step in the process mandated by Section 102(2)(C) of the National Environmental Policy Act, 42 U.S.C. §4332(2)(C), and related NRC regulations, 10 C.F.R. Part 51, that proposed agency decision-making (including significant amendments to regulations) be accompanied by an analysis of the environmental impacts of the proposal. The second step in the process is the solicitation of public comments on the Draft GEIS (this step is pending), and the third step is issuance of the Final GEIS.

As to the sections in the Draft GEIS relating to the environmental impacts and technical aspects of power reactor decommissioning, the Utility Decommissioning Group adopts and incorporates by reference the comments submitted to NRC by the Atomic Industrial Forum. The AIF comments highlight several significant aspects of the Draft GEIS which are of equal concern to the Group.

II. COMMENTS ON FINANCIAL ASSURANCE

Of direct focus in the instant comments is the discussion in the Draft GEIS of the financial assurance aspects of power reactor decommissioning. However, before addressing those aspects specifically, we first question the propriety and necessity of including _any_ discussion of financial assurance in the Draft GEIS. The issue of financial assurance without question arises from Section 182 of the Atomic Energy Act, 42 U.S.C. §2232, which is codified in regulation in 10 C.F.R. §50.33(f) and Part 50, Appendix C, and not from NEPA. These are health and safety considerations, _not_ environmental, and as such are misplaced in the GEIS. There is no law or NRC regulation which requires or even justifies including the financial assurance discussion in the GEIS.

The record in the decommissioning rulemaking already contains NRC Staff analyses reflecting its preliminary views on financial assurance aspects. 2/ It is inappropriate, unnecessary and duplicative to repeat in the GEIS the preliminary views on an issue (financial assurance) arising under the Atomic Energy Act, views which already are in the rulemaking record. Accordingly, the section (§2.6) and repeated discussions (§§0.2.6, 0.15.1.3, 15.1.3) on financial assurance in the Draft GEIS should be deleted.

As to the substance of the financial assurance in the Draft GEIS, we have several comments and suggestions which raise three fundamental points, _viz._, NRC jurisdiction as a matter of law, NRC regulation of power reactors as a matter

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2/ "Assuring the Availability of Funds for Decommissioning Nuclear Facilities," NUREG-0584, Rev. 2 (October 1980); "Financing Strategies for Nuclear Power Plant Decommissioning," NUREG/CR-1481 (July 1980).

of policy, and the need for a comprehensive value-impact appraisal by NRC in the context of the financial assurance issue. We address these points seriatum below.

A. NRC Jurisdiction Regarding Financial Assurance

We have commented to the NRC in the past on the proper role of NRC in decommissioning financing. 3/ We incorporate those comments by reference here. In summary, the NRC lacks jurisdiction or authority over matters of economic regulation and utility financing which would be necessary to impose a particular decommissioning funding arrangement on NRC power reactor licensees. Such matters are properly addressed by State ratemaking agencies or FERC.

The jurisdiction of the States and FERC is specifically preserved in Section 271 of the Atomic Energy Act, 42 U.S.C. §2018, which provides that nothing in the Act affects "the authority or regulations of any Federal, State or local agency with respect to generation, sale or transmission of electric power produced through the use of nuclear facilities." In addition, Section 272 of the Act, 42 U.S.C. §2019, subjects NRC licensees that either transmit or sell at wholesale in interstate commerce electric

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3/ Letters to NRC from Utility Decommissioning Group dated July 15, 1978 and November 6, 1979, commenting on Advance Notice of Proposed Rulemaking and Draft NUREG-0584, respectively.

energy generated by nuclear power reactors to the regulatory provisions of the Federal Power Act.

The NRC Staff does not dispute that it lacks jurisdiction to prescribe funding arrangements for decommissioning cost recovery. For example, in the Staff's draft report on decommissioning financing, it noted that "NRC should avoid imposing requirements so specific that they conflict with State or federal rate-making authority or with utility accounting practices, particularly when the effects of those requirements are not clear." 4/ Likewise, the Staff represented to the States at a workshop with them in 1979 that the NRC "is not in the ratemaking business and does not want to [be]," and that the NRC could not "preempt other authorities" in the realm of economic regulation. 5/

The NRC has jurisdiction and authority to require a licensee to demonstrate that it possesses or has reasonable assurance of obtaining the funds necessary to cover, *inter alia*, the estimated costs of permanently shutting down the facility and maintaining it in a safe conditions. NRC regulations require an applicant for a power reactor operating license to demonstrate that it is financially qualified to

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4/ NUREG-0584, Rev. 2, at p. 57 (see Note 2, *supra*).

5/ "State Workshops for Review of the Nuclear Regulatory Commission's Decommissioning Policy," NUREG/CP-0008 (December 1979), at p. 242.

decommission the reactor under review (10 C.F.R. Part 50, §50.33(f) and Appendix C). These regulations are founded on Section 182 of the Atomic Energy Act, 42 U.S.C. §2232, which provides for a determination by the NRC that an applicant is financially qualified to perform the activities contemplated by the license.

Thus, the NRC recognizes the need to tailor any decommissioning regulations to avoid overstepping its statutory authority. It is presumably this recognition that led the Staff to state that as to financial assurance "the NRC should allow a wide latitude of approaches to implement some standard adequate level of assurance." 6/ Yet a close analysis of the discussion on financial assurance in the Draft GEIS reveals that the Staff proposes to confine sharply the realistic funding options which it will deem acceptable. At bottom, the only reasonable regulatory approach for the Staff to propose to the Commission in this area is that each outstanding operating license or application for an operating license be reviewed on a case-by-case basis to determine if reasonable assurance exists that decommissioning funds will be available when needed. This objective is not accomplished by the proposal to proscribe some (the most widely-used) funding options generically, without any consideration of specific facts for individual cases.

6/ NUREG-0584, Rev. 2, at p. 57.

In the Draft GEIS, the Staff states that the following funding mechanisms provide adequate assurance: (1) prepayment, (2) insurance, sureties, bonds, and letters and lines of credit, or (3) sinking funds. However, as to sinking funds, the Staff states that this option "would have to be supplemented by decommissioning insurance or other mechanisms [such as sureties or bonds] which would pay the difference" in the event of premature closure between funds escrowed and funds needed to decommission. The Staff also states that negative net salvage depreciation and reinvestment in plant would be considered an adequate funding mechanism "only if it were supplemented by substantial additional financing mechanisms" (i.e., insurance or sureties). 7/

In so concluding, the Staff has effectively proscribed all funding options other than prepayment, for it has tied use of the other options to unavailable or unworkable supplemental options. For example, the Staff has recognized correctly that "it is not yet clear that the [insurance] option will actually be available." 8/ In 1979, the Staff sought the views of Nuclear Mutual Limited ("NML") and the two nuclear liability insurance pools (American Nuclear Insurers ("ANI") and Mutual Atomic Energy Liability

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7/ Draft GEIS, at pp. 2-16 to 2-17.

8/ NUREG-0584, Rev. 2, at p. 49.

Underwriters ("MAELU")) on the possible role of the nuclear insurance industry in the decommissioning realm. NML responded that "decommissioning insurance was probably unnecessary and, in any case, violated the insurance principal of spreading risk among similarly exposed insureds." ANI and MAELU indicated in informal discussions with the Staff the preliminary view that the nuclear insurance industry in theory might serve a role with regard to premature decommissioning insurance. 9/ Most recently, ANI advised the Staff that no study of the feasibility of such an insurance program had been undertaken or is planned by ANI. 10/

In order to fill this void, the Staff has commissioned a six-month study into the feasibility of a self-insurance pool among nuclear utilities to cover premature decommissioning. 11/ Obviously, it would be prudent regulatory policy at least to await completion of that study before stating publicly in the GEIS or elsewhere (such as in NUREG-0584, Rev. 2) that the new NRC approach to determining financial qualifications for decommissioning will in effect hinge on insurance. The most which could be said prudently

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9/ Id., at p. 48.

10/ Letter to R. S. Wood (NRC) from J. Marrone (ANI) dated March 16, 1981.

11/ NRC Request for Proposal No. RS-OSD-81-001; "Evaluation of Utility Self-Insurance as an Option for Assuring Funds for Decommissioning" (October 7, 1980).

at this stage of development of the rulemaking record is that the feasibility of insurance is being studied, and that formulation of the Staff's position on the insurance question must await completion of the study.

This failure of the Draft GEIS is due to the fact that it recites and adopts the preliminary conceptual thoughts of the Staff on financial assurance contained in NUREG-0584, Rev. 2 without recognition and restatement of the qualifications and caveats in NUREG-0584, Rev. 2, noted above. This shortcoming highlights the need for the Staff to refrain from attempting to summarize in an environmental document (the GEIS) the issue of decommissioning funding, which the Staff has recognized "is a complex problem with few definitive answers." 12/

Likewise, it is clear from the NRC Staff study on sureties and bonding that these options cannot play any part in the financial qualifications test. In fact the Staff has dismissed these options for power reactor decommissioning funding "as unavailable and not adequately meeting the evaluation criteria." 13/ Finally, as to letters and lines of credit, there has been no study by the Staff as to the feasibility or availability of those approaches for decommissioning funding. Letters and lines of credit most likely suffer from the same

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12/ NUREG-0584, Rev. 2, at p. 56.

13/ *Id.*, at p. 46.

shortcomings as sureties and bonds (*e.g.*, revocability impairs long-term assurance), and thus cannot be included as meaningful funding options.

Thus, the only funding option which the Staff states in the Draft GEIS will be acceptable alone (without supplementation) is prepayment. Since the availability and feasibility of insurance is uncertain, and sureties, bonds and letters and lines of credit are unavailable or unworkable, the Staff's requirements in the Draft GEIS as a practical matter preclude the use of all options other than prepayment.

This result is totally unsupported by any factual basis or reasonable regulatory policy, and will almost certainly lead to a conflict with ratemaking agencies. The result also inevitably will be that electric power costs to the public will be increased without any meaningful enhancement of public health and safety. In these circumstances, the Staff should delete all discussion of financial assurance in the Draft GEIS, and leave treatment of that issue for the more thoughtful and informed process of which NUREG-0584, Rev. 2, and the forthcoming study on insurance are parts.

B. NRC Regulatory Policy Regarding Financial Assurance

1. Reasonable Assurance. The NRC Staff persists with the notion that the objective of this rulemaking should be to require that licensees provide a "high degree of assurance"

that decommissioning funds will be available when needed. 14/ Few dispute the notion that some reasonable level of financial assurance is appropriate. The issue is how to prescribe a level which is adequate to protect public health and safety yet within reasonable bounds of cost-effectiveness. NUREG-0584, Rev. 2, more accurately states the proper objective as NRC approval of "a wide latitude of approaches to implement some standard level of assurance." 15/

The correct level of assurance which should be required for decommissioning financing is presented in a much broader context in present NRC regulations. Prior to issuing a license to operate a power reactor, the NRC must find, *inter alia*, that "[t]here is reasonable assurance (i) that the activities authorized by the operating license can be conducted without endangering the health and safety of the public. . ." (10 CFR §50.57(a)(3) (emphasis added)).

The Commission has long recognized the appropriateness of the "reasonable assurance" standard in making health and safety determinations, including those as to the financial qualifications of applicants. The Atomic Energy Act of 1954, as amended, 42 U.S.C. §2011, *et. seq.*,

14/ Draft GEIS, at p. 2-15.

15/ NUREG-0584, Rev. 2, at p. 57.

clearly supports this standard, and the Courts have found the standard to be consistent with requirements of the Act and have affirmed the Commission's use of it.

The "reasonable assurance" standard was apparently first utilized in the regulations promulgated soon after the enactment of the Atomic Energy Act of 1954. The provisions of 10 CFR §§50.35 and 50.40(a) required applicants to provide "reasonable assurance" that the facility could be constructed and operated without undue risk to the health and safety of the public (21 Fed. Reg. 358 (January 19, 1956). The standard remains in effect in those sections to this day.

The Supreme Court subsequently found that the required finding of "reasonable assurance" that the health and safety of the public will not be endangered "comports with the requirements of [the Act] concerning the issuance of a license to operate" and "is a valid exercise of the rule-making power conferred upon [the Commission] by statute" with respect to the issuance of a construction permit. Power Reactor Development Company v. International Union of Electrical, Radio and Machine Workers, 367 U.S. 396, 407 (1961); accord, New England Coalition on Nuclear Pollution v. NRC, 582 F.2d 87, 93 (1st Cir. 1978); North Anna Environmental Coalition v. NRC, 533 F.2d 655, 659 (D.C. Cir. 1976); Nader v. NRC, 513 F.2d 1045, 1052 (D.C. Cir. 1975).

The adoption of the "reasonable assurance" standard for application to the financial qualifications requirement of the

Act occurred with the amendments to 10 CFR §50.33(f) and the promulgation of Appendix C to 10 CFR Part 50 (33 Fed. Reg. 9704 (July 4, 1968)). The Commission indicated there that Section 182(a) of the Act, 42 U.S.C. §2232(a), contemplated that financial qualifications of applicants were to be judged by the same standard (protection to the public health and safety) as are technical qualifications. It was in this context that the "reasonable assurance" standard was adopted and applied to the review to determine an applicant's financial qualifications to operate and safely shut down the facility.

Since the "reasonable assurance" standard clearly reflects the requirements of the Act as interpreted by the Commission and the Courts, it should be followed as the applicable standard in the evaluation of decommissioning funding alternatives. The Staff's failure to utilize the standard in the Draft GEIS (or NUREG-0584, Rev. 2) is inconsistent with these legal precedents, and therefore unlawfully influences its conclusions. Certainly there is no factual basis in the rulemaking record or elsewhere to support a higher regulatory standard for decommissioning financing than is now required by law for actual operation of a power reactor. Yet the Staff's proposal on financial assurance in the Draft GEIS (and NUREG-0584, Rev. 2) would create that higher standard for decommissioning financing.

Thus, the essential issue before the Staff is not to identify which option provides the <u>highest</u> degree of assurance, but to determine the range of options which provide reasonable assurance that decommissioning funds will be available when needed. The efforts by the Staff to rank relatively the levels of assurance which each option provides in effect precludes one or more alternatives which may indeed provide "reasonable assurance" that decommissioning funds will be available when needed.

The proper administrative procedure for determining whether reasonable assurance for decommissioning financing exists is the case-by-case evaluation, not a generic regulation. Only by evaluating each application or license on the basis of the facts unique to that applicant or licensee can any meaningful and rational determination be made. The Staff surely must recognize that a financing approach which may be inadequate for one NRC licensee could be more than adequate for another. In the interests of regulatory efficiency and cost-effectiveness, the NRC Staff must abandon its present course (which clearly is headed toward a proscriptive generic proposal for decommissioning financing) in favor of one embodying case-by-case reviews and general guidelines for determining whether some reasonable level of financial assurance is demonstrated. Only such an approach will assure that NRC regulations account properly for the facts that various entities (investor-owned utilities, rural electric cooperatives, public utility districts, municipals, and even a Federal agency) are licensees of the NRC, that the methods of cost recovery by these entities vary, and that there may be valid distinctions between NRC licensees within a given class (i.e., investor-owned utilities) which could justifv different treatment for those licensees.

2. Premature Decommissioning. It is apparent that the Staff's entire approach to decommissioning financing is pervaded by the notion that premature decommissioning is an event which must be assumed. The Staff states in the Draft GEIS that "[b]ecause of the possibility of premature closure of the facility, financial assurance provided by the licensee should also contain a mechanism enabling funds for the full cost of decommissioning to be made available at any time during facility operation". 16/ Such a policy is geared to the worst-case scenario where a financially-insolvent licensee is faced with premature decommissioning without any or all of the funds necessary to perform the task. Obviously, this is a situation which is highly undesirable and which must be avoided if possible.

However, the solution is not to require all licensees to structure decommissioning financing arrangements on the assumption that all may realistically face insolvency and premature decommissioning. That assumption is naive, simplistic, and very expensive to consumers (see Part III.B.3, infra). Yet the Staff is basing its approach on that assumption without

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16/ Draft GEIS, at p. 2-15.

even examining the facts regarding the probability of premature decommissioning. In effect, the Staff posits that if premature decommissioning is even possible, then decommissioning financing regulations must assure that funds will be available at any time.

Of course, that approach cannot be reconciled with the NRC's overall approach to power reactor licensing. If the NRC were to regulate in a manner designed to preclude all possible events, then no power reactor would ever be licensed to operate. The Congress, the courts, and NRC all have recognized, however, that regulation of nuclear power involves the assessment and acceptance of reasonable risks. It is this recognition which lead to development and judicial affirmance of the "reasonable assurance" standard. (See Part II.B.1, supra.)

In fact, an evaluation of the probabilities associated with premature decommissioning funding would reflect that the overall risk is very low. First, the probability of an event which occassions premature decommissioning (and not simply repair and restart) is unarguably low. Second, the probability of such an event causing licensee insolvency is also low, particularly since participation in the Nuclear Electric Insurance limited insurance pool for recovery of replacement power costs is so wide-spread among NRC licensees, and since the demand for funds to decommission would occur over time. Of course, multiplying these low probabilities yields an even lower overall probability of premature decommissioning and insolvency.

The solution is to permit each licensee to structure a responsible decommissioning cost recovery approach, consistent with the dictates of pertinent ratemaking agencies. The Staff should satisfy itself on a case-by-case basis that appropriate provisions have been or are being made to assure that funds will be available. In the case of some licensees, this might require placement of funds over time in a segregated account, or even prepayment. In the case of other licensees, a very large corporate net worth might even be adequate without more. Periodic review by NRC and judicious use of NRC regulations 17/ would assure that prior determinations of financial qualifications to decommission remain valid or that appropriate action is taken to account for changed conditions.

An integral part of the case-by-case financial qualifications review would be the realization that any demand for funds to decommission (whether routinely or prematurely) would occur over time and not at once. The Draft GEIS recognizes that DECON for a large PWR will take approximately four years, and that SAFSTOR will take approximately two years for preparation (an effort of much lower cost than DECON) and thereafter up to 100 years of

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17/ 10 CFR §50.33(f); Appendix C, §§III and IV of 10 CFR Part 50; 10 CFR §50.54(f); and 10 CFR §2.206.

security and surveillance. 18/ Thus, the demand for decommissioning funds would be spread over several years, and a licensee would be afforded the opportunity to finance the decommissioning activity (if funds were not already available) in an orderly manner as part of its overall financing program.

Nevertheless, some situations may exist or arise which would justify the extraordinary option of prepayment, and the Staff could make those determinations in the context of each situation. Case-by-case analysis would provide the Staff with the opportunity to determine itself whether the two "uncertainties" it perceives to exist on the financial assurance issue are justified for a specific licensee. These "uncertainties" are the inability to predict the financial solvency of a licensee in the future and "that, potentially, a facility could be forced to shut down prematurely." 19/ Case-by-case assessments and, as noted above, periodic review by NRC and judicious use of NRC regulations should dispel the first "uncertainty" as to licensee solvency. As to the second "uncertainty", we submit (as discussed above) that the mere possibility of an occurrence is an insufficient basis for establishing and imposing on all licensees the restrictive and costly regulatory scheme contemplated by the Staff.

18/ Draft GEIS, at pp. 2-5 to 2-7.

19/ Id., at p. 2-15.

C. Need for Comprehensive Value-Impact Analysis

It is a fundamental policy of the NRC that the regulation of nuclear power will be accomplished in a cost-effective manner, consistent with public health and safety. The NRC has directed "that value-impact analyses be conducted for any proposed regulatory actions that might impose a significant burden on the public (where the term public is defined in its broadest sense)." Value-impact analyses are required for "unique or generic licensing actions and other non-routine, non-recurring regulatory actions requiring Commission decision." This policy dictates that "where there are alternative means of realizing equivalent benefits in regulatory matters, cost should be a prime consideration." 20/

Principal elements of value and impact evaluations include a statement of the objective of the proposed action and discussion of the alternatives to the proposed action (including preservation of the *status quo*). Another principal element is the incremental benefits of the proposed action when compared with the alternatives, and the relative costs (including side effects) for those incremental benefits. 21/ For example, the Commission has directed that value-impact analyses

20/ "Guidelines for Conducting Value-Impact Analysis," at pp. i, ii, iii, and 5 (January 1978) ("Guidelines"). *See also* "Value Impact Guidelines," SECY 77-388 (July 1977) and SECY 77-388A (November 1977).

21/ Guidelines, at pp. iv-v.

"include alternatives which are superior in estimated value (greater benefit) to the status quo or base case but are not quite as effective as the recommended staff position in terms of, say, increasing the public safety." The Commission observed that if compared with the most effective action there exists an alternative which would provide a large measure of the value for a reduced cost, then the Staff should include the evaluation of that alternative in the value-impact analysis. 22/

Obviously, the NRC Staff must prepare a comprehensive value-impact analysis on the decommissioning rulemaking in general and the financial assurance aspect in particular. The Staff has recognized that its preliminary proposal on financial assurance could result in a cost of approximately $3.5 billion if licensees with currently operating reactors are required to deposit decommissioning funds as a condition of continued operation. 23/ The Staff has also recognized that even if immediate prepayment is not required of any such licensee, a national annual cost of approximately $140 million will result if annual contributions from current customers are collected to accumulate decommissioning funds over the operating life of the plant. 24/ Such huge potential costs to the public

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22/ Guidelines, at pp. 14-15.

23/ NUREG-0584, Rev. 2, at p. 36; Draft GEIS, at p. 2-17.

24/ Summary of Rulemaking, 44 Fed. Reg. 77894, 77895 (November 24, 1980).

certainly should trigger the preparation of a comprehensive value-impact analysis to accompany the Staff's proposal to the Commission.

As to the financial burdens which the Staff's proposals will have on NRC licensees and ultimately all consumers of electricity, the Draft GEIS attempts to mitigate or dismiss them offhand. For example, in addressing the possible need for NRC licensees to raise $3.5 billion to finance the Staff's approach, the Staff recognizes that the effort "might result in an increase in the cost of capital to the utilities . . . ." Yet the Staff simply suggests that it "should not prove unmanageable." The Staff also foresees less burden on the capital market if "many of the plants . . . choose the sinking fund method." 25/ However, as noted above (Part II.A, *supra*), since the sinking fund option must be supplemented by insurance or sureties (both of which are unavailable) before it will be acceptable to the Staff, the sinking fund option is effectively precluded from use.

In fact, a need to raise $3.5 billion to fund decommissioning prepayment accounts would have a very significant impact on the capital financing market. In 1980, total capital financing placements for the electric utility industry (nuclear and non-nuclear) were $3.92 billion in

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25/ Draft GEIS, at p. 2-17.

common stock and $2.12 billion in preferred stock. 26/ Thus, using 1980 as the base year, a $3.5 billion increase in demand for capital would increase sales of equity by 58%. Of course, secured debt (bonds) should not be relied upon to fund the decommissioning prepayment account since appropriate debt equity-ratios must be maintained and, generally, there would be no assets against which debt instruments could be issued. Nevertheless, even assuming *arguendo* that secured debt was feasible, a $3.5 billion increase in demand for capital would increase total financing placements (debt and equity) by over 27%. 27/ An increase of this magnitude would result in a material increase in the cost of capital funds for utilities.

This cavalier manner of assuming that easy and cost-effective solutions exist to solve the major problems (*i.e.*, cost and financing) raised by the Staff's proposal is unsupportable and irresponsible. And even more disturbing is the total failure on the part of the Staff to evaluate the relative enhancement of public health and safety which would be purchased through the raising of these funds and their dedication to decommissioning, in contrast to a more flexible approach which contemplates case-by-case analyses of the decommissioning financing option which each

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26/ Irving Trust Financing Calendar (January 2, 1981).

27/ Total capital placements through sale of bonds in 1980 were $6.74 billion. *Id*.

licensee has adopted or proposes to adopt in conjunction with pertinent ratemaking agencies.

The Staff's conclusions regarding the impact of its proposal on individual consumers are also unsupported. The Staff concludes that "whichever funding mechanism is used should not have a significant impact on cost to consumers." The Staff then states, as if the conclusion has universal application, that "[o]ne study has estimated that the difference in cost between the various funding mechanisms would result in less than a 1% difference in the total bill of a representative utility customer." 28/

Of course, we challenge the implication by the Staff that a 1% increase in the bill of the "representative" electric utility customer is insignificant, particularly in the absence of a comprehensive study (the value-impact analysis) on what each customer gains by the increase and what alternative approaches would cost. But in any event, the reliance by the Staff on the referenced study 29/ is misplaced. That study relates only to the case study of a particular NRC licensee. The conclusions in that study on costs to consumers as a percentage of an average bill have no generic applicability to all NRC licensees.

28/ Id.

29/ "Financing Strategies for Nuclear Power Plant Decommissioning", NUREG/CR-1481 (July 1980).

Such costs and percentages are obviously highly sensitive to the fuel mix of each utility and the assumed cost of decommissioning, and the study specifically notes that fact. 30/ The costs and percentages are also highly sensitive to assumptions for rate of return, costs of capital and inflation. Thus, even for NRC licensees that have less installed nuclear capacity in rate base than the utility in the case study, costs to consumers as a percentage of an average bill may be higher. Again, this strongly suggests the need for the Staff to preserve flexibility in the decommissioning regulations through case-by-case reviews.

The study referenced by the Staff does, however, confirm that the prepayment option is approximately a factor of three more expensive (in terms of revenue requirements) than the internal reserve option. 31/ This conclusion is consistent with other studies on the subject, 32/ and must be addressed fully in the value-impact analysis. Simply stated, the issue is whether the incremental enhancement of public health and safety which would be occasioned by the Staff's proposal justifies the outlay of hundreds of millions of dollars (or even several billion dollars) on a national scale, or whether a more reasonable, orderly collection of

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30/ *Id.*, at p. IV-2.

31/ *Id.*

32/ NUREG-0584, Rev. 2, at p. 17, n. *.

decommissioning funds over time (for most licensees) would return a much more desirable ratio of benefit to cost. We believe that the value-impact analysis which the Staff must perform will compel the latter approach as an integral part of a case-by-case regulatory approach.

III. CONCLUSION

We appreciate the opportunity to comment on the discussion in the Draft GEIS on financial assurance. In sum, we urge the Staff to delete any discussion of financial assurance (a safety issue) in the Draft GEIS. If the discussion is retained, the Staff should substantially revise the Draft GEIS to account for the qualifications and caveats in NUREG-0584, Rev. 2, upon which the Draft GEIS relies, and to state that any conclusions on a Staff position must await the outcome of the forthcoming insurance study and preparation of a comprehensive value-impact analysis. We believe that the value-impact analysis will compel the preservation of a case-by-case approach (rather than generic rule) in which the Staff will determine for each licensee on the basis of a specific set of facts whether reasonable assurance of financial qualifications to decommission has been demonstrated.

Sincerely,

NSReynolds

Nicholas S. Reynolds
Counsel to Utility Decommissioning
Group

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(25)

PROPOSED RULE PR-30,40,50,70,72
(46 FR 11666)

April 27, 1981

Secretary of the Commission
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Docketing and Service Branch

MAY 5 1981
Office of the Sec.
Docketing & Ser.
Branch

Re: Draft GEIS on Decommissioning of Nuclear Facilities
(NUREG-0586)
Duke File: GS-N-5.10

On February 10, 1981 the Nuclear Regulatory Commission published in the Federal Register (FR 11666) a Notice of Availability of the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, dated January, 1981. The Federal Register Notice invited comments from interested persons on the Draft GEIS.

Duke Power Company currently has in operation 4 nuclear reactors and has under construction 5 additional units scheduled for operation between now and the mid-1990's. In preparing for the development of these nuclear reactors, Duke has considered the ultimate need to decommission these units and on that basis submits comments to the Draft GEIS.

Duke Power Company is a participant in the Utility Decommissioning Group which filed comments on the Draft GEIS on April 22, 1981. In addition, Duke has been involved in the development of comments by the Decommissioning Subcommittee of the Atomic Industrial Forum. The AIF comments highlight several significant aspects of the Draft GEIS which are of concern to Duke Power Company. The Utility Decommissioning Group comments also reflect the views of Duke Power Company. By this letter, Duke adopts and endorses the comments of both these groups and urges the Commission to take the appropriate actions recommended by the groups in the development of any rules or new criteria for the decommissioning of power reactors.

As a specific comment, Duke believes that the NRC Staff should consider, in great detail, the potential for the permanent entombment of power reactors as a decommissioning mode. This potential alternative could provide the utility industry with the most economical and environmentally acceptable decommissioning mode. It should not be ignored by the NRC.

April 27, 1981
Secretary of the Commission
Page Two

We look forward to the issuance of the Final GEIS on this decommissioning re-evaluation and would expect to participate in any proposed rulemaking that may take place. We believe that preservation of a case by case approach for decommissioning is most practical and urge the Staff to preserve that option.

Very truly yours,

L. C. Dail, Vice President
Design Engineering Department

DBB/pam

cc: Nicholas S. Reynolds
E. David Harward

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, 175 CURTNER AVE., SAN JOSE, CALIFORNIA 95125

Mail Code 861

NUCLEAR FUEL

AND SERVICES

DIVISION

SPENT FUEL SERVICES OPERATI

DMD-541

26

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,72
(46 FR 11666)

Docketed
USNRC
MAY 5 1981
Office of the Sec.
Docketing & Svc.
Branch

April 27, 1981

Samual J. Chilk
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Docketing and Service Branch

RE: Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586

Gentlemen:

Enclosed pleased find the comments of General Electric Company Spent Fuel Services Operation regarding the above captioned matter.

Respectfully,

GENERAL ELECTRIC COMPANY

D.M. Dawson, Manager
Licensing & Transportation

DMD:CCH:bn

Enclosure

GENERAL ELECTRIC COMPANY
NUCLEAR ENERGY GROUP
NUCLEAR FUEL AND SERVICES DIVISION
SPENT FUEL SERVICES OPERATION
COMMENTS ON THE DRAFT GENERIC
ENVIRONMENTAL IMPACT STATEMENT ON
DECOMMISSIONING OF NUCLEAR
FACILITIES, NUREG-0586

These comments are submitted by the General Electric Company Spent Fuel Services Operation, on the Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, in response to the request for comments published in the Federal Register on February 10, 1981.

A. INTEREST

The General Electric Company Spent Fuel Services Operation is the licensee of the Morris Operation spent fuel storage facility, co-dockets no. 70-1308 and 72-1. A decommissioning plan has been filed for the Morris Operation as part of the license renewal application that is currently pending before the NRC. As the sole applicant, to date, for licensing under 10 CFR Part 72, and because a decommissioning plan has previously been submitted, we have an active interest in the application of decommissioning criteria to independent spent fuel storage installations.

B. GENERAL COMMENTS ON DRAFT STATEMENT

The proposed residual radioactivity levels for unrestricted use of a facility attributed to "preliminary guidance" by EPA, seem to violate one of the precepts which they claim to encompass, i.e., that the residual radioactivity levels be measurable with realistic dose assessment methodology. The key word is "realistic." Although specific radionuclides can be detected statistically in quantities corresponding to the proposed 10 mrem/yr, the 10 mrem/yr is the proposed maximum residual level and therefore is not an acceptable value for industry to use for control during decontamination efforts (A control value is often established at less than half the limiting value). Even though the statistical detection capability exists, it is not a realistic means of measurement in terms of the results desired ... i.e., assuring the health and safety of the public with unrestricted access to decommissioned properties.

Oak Ridge National Laboratory's study results are not reassuring in this case. What appears realistic to ORNL, and their excellent staff of senior scientists, engineers, electronics and computation experts,may be rather non-realistic in a commercial context such as decontaminating large complex facilities and equipment and determining residual radioactivity levels.

General Electric suggests that the NRC thoroughly consider the consequences of imposing un-realistic criteria in this area and then reassess the stated criteria from the point-of-view of a commercial industry rather than that of a national laboratory.

(27)

DOCKET NUMBER PROPOSED RULE PR-30,40,50,70,72 (46 FR 11666)

General Offices: 212 West Michigan Avenue, Jackson, Michigan 49201 • (517) 788-0550

Docketed USNRC MAY 5 1981 Office of the Sec. Docketing & Svc. Branch

April 30, 1981

Secretary of the Commission
US Nuclear Regulatory Commission
Washington, DC 20555

Attention Docketing and Service Section

The following comments concerning NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities", are presented for your consideration. The comments pertain to Section 2.6 of the subject document and refer to two statements which are particularly worrisome to Consumers Power Company. The statements are:

> "The problem with the internal or unsegregated funding method is the lack of assurance that funds will be available to pay for decommissioning. Because this method depends on financing internal to the licensee, the unfunded reserve is vulnerable to any event or situation that undermines the financial solvency of a utility." (p 2-16)

> "Under the NRC's responsibility to protect public health and safety by assuring that funds are available for a safe decommissioning, the internal reserve would be considered an adequate funding mechanism only if it were supplemented by substantial additional financing mechanisms (such as insurance or some other surety arrangements) that overcome the assurance deficiencies." (p 2-17)

The comments are:

1. The first statement evidences a lack of confidence on the part of the authors that the utility regulators will carry out their constitutional and statutory responsibilities for setting utility rates at a level which will maintain the financial health of the utilities while supplying needed services at a reasonable cost to users. While such concern may be justifiable in light of the financial performance of the electric utility industry during the last decade, the contribution of the unprecedented rise in energy costs since 1973 to this present situation must not be overlooked. In the coming years, the financial health of the industry can be expected to improve as the rate of increase in energy costs and other costs of providing services abates, and as the regulators better recognize the importance of the timely rate increases. Consumers Power Company believes that the importance of the authors' lack of confidence in the future performance of state and federal regulators is not sufficient to warrant NRC's using it as a basis for a policy decision on the funding for decommissioning.

Also, it should be recognized that external decommissioning funds entrusted to a trustee would be no more immune to threatened inadequacy associated with economic decline than would internal unsegregated decommissioning funds. Municipal and other governmental debt obligations can be unstable, and the risk of instability is increased if the political structure is used to restrict external fund investment to the debt obligations of the state or municipalities in which the utility operates; such politically-motivated investment restrictions have, of course, already been imposed. Therefore, Consumers Power Company concludes that insurance or other surety arrangements are equally desirable for internal unsegregated decommissioning provisions and for external funds.

2. The second statement says that "substantial additional financing mechanisms (such as insurance or some other surety arrangements)" would be necessary to justify internal funding, yet the subject document on page 2-16 discusses the fact that the availability of such arrangements will be questionable. In addition, the development of industry and government sponsored insurance funds has not progressed beyond the preliminary discussion stage. From these facts, one could conclude that the intent of this report is to establish that internal funding is not a viable alternative. However, Consumers Power Company believes that this is an incorrect conclusion and requests that future statements by NRC and its contractors make it clear that the internal funding option should not be abandoned until it is proven to be inferior to some vialbe alternative.

3. In general, it cannot be denied that the current financial provisions for decommissioning operating plants are not adequate. For Consumers Power Company, the older of its two operating plants is expected to leave commercial service in nineteen years, yet the current retail electric rates set by the Michigan Public Service Commission include no provision for paying the cost of decommissioning. Unfortunately, the longer the delay before the initiation of a decommissioning fund, the higher the ultimate cost to the rate payers will be. Consumers Power Company fears that the discussion of the necessity for insurance or surety arrangement might delay initiation of the accumulation of decommissioning funds and urges the NRC to take precautions which will ensure that such a situation does not arise. Collection of the funds should begin promptly. If deemed necessary, the insurance or surety arrangements can be added later.

Please consider these comments in future actions concerning the topics discussed in NUREG-0586.

D P Hoffman
Nuclear Licensing Administrator

PSEG

Public Service Electric and Gas Company 80 Park Plaza, T16D Newark, N.J. 07101 201/430-8217

Robert L. Mittl
General Manager - Licensing and Environment

April 29, 1981

MAY 14 1981 Office of the Secretary Docketing & Service Branch

Mr. Samuel J. Chilk
Secretary to the Commission
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Chilk:

COMMENTS ON NUREG-0586
DRAFT GENERIC ENVIRONMENTAL IMPACT
STATEMENT ON DECOMMISSIONING OF
NUCLEAR FACILITIES

We have reviewed the above draft and offer the following comments addressed specifically to the funding of decommissioning costs.

While the draft is an environmental impact statement, it also addresses the area of funding decommissioning costs. The Nuclear Regulatory Commission (NRC) requires from the nuclear facility licensee the availability of adequate funds to decommission a facility. Because of the possibility of premature closure, the NRC specifies funding mechanisms considered reasonable for providing the necessary financial assurance to properly decommission. Some of the funding mechanisms mentioned were internal reserve, sinking fund and prepaid fund.

In discussing financial assurance, the NRC states that the method of funding does not have a significant impact on revenue requirement. They also state that "it is reasonable to estimate that current decommissioning costs are less than 10% of present worth of commissioning cost." As studies within the utility industry have shown, the sinking fund method is more than twice as expensive as internal reserve, and a prepaid fund more than three times as expensive. In addition, decommissioning costs based on current dollars have been estimated at well over 100% of construction costs. Consequently, the method of funding selected would seem to have a significant impact on revenue requirements.

The funding method selected must provide a balancing of the interests of the customers (lowest reasonable rates), the stockholders (preservation of a utility's well-being), and the public in insuring that provisions are adequate and the funds are available for decommissioning. To achieve the balancing of such interests, the internal reserve on

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(29)

DOCKET NUMBER PR-30,40,50,70,72
PROPOSED RULE (46 FR 11666)

ANPP-17998-EEVBJr/CB
May 19, 1981

Docketed USNRC
MAY 27 1981
Office of the Sec. Docketing & Ser. Branch
mdv

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Re: Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities

Dear Sir:

In accordance with the Notice of Availability of the referenced document as published at 46 Federal Register 11666 (February 10, 1981), and amended at 46 Federal Register 15278 (March 5, 1981), Arizona Public Service Company submits the following comments respecting the assurance of funding for decommissioning.

1. Of the various funding alternatives discussed in the Draft Generic Environmental Impact Statement (DEIS), only one alternative -- prepayment -- satisfies the dual requirement of being (1) presently available and (2) acceptable to the NRC without supplementation by other mechanisms. As to the remaining alternatives, decommissioning insurance and surety bonds of the size necessary are simply unavailable today. The DEIS recognizes as much at least with respect to surety bonds. DEIS at 2-16. As to a line of credit, it seems to be unrealistic to expect a creditor who has likely loaned funds to the utility for construction of the nuclear power plant to be willing to extend a line of credit to the utility to be used for decommissioning in the event of a premature closing of the facility. Finally, as to both segregated and unsegregated sinking funds, the DEIS states that these funding mechanisms would have to be supplemented by substantial additional financing mechanisms to provide assurance of funding in the event of a premature closing. Since there would be zero monies in such funds at the outset of commercial operation of a facility, the only way to provide financial assurance would seem to be the prepayment mechanism. Thus, although the DEIS discusses several funding alternatives, only the prepayment mechanism would be available under the DEIS' approach to establishing financial assurance. Yet, the prepayment mechanism is probably the most unsatisfactory alternative to the nuclear industry

Acknowledged by card 5/28/81 mdv.

because of the need to raise the entire amount for decommissioning at the outset of commercial operation. More thought needs to be given to other alternatives and to the criteria for determining whether a particular alternative is acceptable. (See comments nos. 5 and 6.)

2. The DEIS fails to address adequately the relative costs of the various funding mechanisms. It simply notes that (1) the unsegregated sinking fund is considered to be less expensive in terms of net present value and (2) one study has estimated that the difference in cost between the various funding mechanisms would result in less than a 1% difference in the total bill of the utility customer.

3. As to the prepayment method, the DEIS fails to address how the fund may be used during the operating life of the facility. For example, may the fund be invested and, if so, who is to decide how it may be invested and what guidelines will apply to such an investment? The ratemaking impacts associated with establishing a prepayment fund have also not been considered. For example, should consumers or stockholders pay for the fund? What are the respective impacts associated with funding by these two sources? Although ratemaking impacts are largely within the jurisdiction of state regulatory agencies, the Final Environmental Impact Statement (FEIS) should be sensitive to the manner in which funds will be raised and who will be providing such funds.

4. Although the DEIS in several instances makes reference to premature closing of a nuclear facility, nowhere does it address the potential cleanup costs associated with a premature closing resulting from an accident in combination with decommissioning costs. TMI-2 has shown that the cost of cleanup may far exceed estimated decommissioning costs. In a situation involving such a premature closing, the intent is unclear respecting whether or not decommissioning funds may be used for cleanup where the failure to conduct cleanup operations presents more serious health and safety questions than the decommissioning. This matter should be addressed in the FEIS.

5. The DEIS fails to examine whether the decision as to which funding mechanism should be applied may vary from one licensee to the next. For example, where a particular nuclear power plant comprises a significant portion of a utility's generating capacity, i.e., something close to or greater than the utility's reserve margin, the loss of such plant will likely require the utility to purchase power from neighboring facili-

ties to meet its generating requirements. Such purchases, extended over a long period, could have the effect of jeopardizing the utility's financial condition if the state regulatory commission refuses to permit the utility to pass on the cost of purchased power. For such a utility, the prepayment mechanism may be the most appropriate way of providing financial assurance for decommissioning.

On the other hand, where a particular nuclear power plant comprises a relatively small portion of a utility's generating capacity, i.e., something less than the utility's reserve margin, the loss of such plant would not necessarily require the utility to purchase power. Instead, it could draw upon its other generating sources to meet its generating requirements. In such a situation, if the utility is permitted to pass on increased fuel costs, the utility's financial condition would remain strong and creditors would be more likely to lend the utility the funds necessary for decommissioning. Therefore, as to such a utility, there would not appear to be a need for application of the prepayment mechanism. Instead, either a segregated or unsegregated sinking fund mechanism would seem to be sufficient.

In sum, the DEIS should recognize that the manner in which the various funding mechanisms are applied should remain flexible to the abilities of individual licensees to cope with the loss of a nuclear facility. In its present form, the DEIS simply fails to deal adequately with this matter.

6. The DEIS notes that the unsegregated sinking fund is generally favored by utilities because it is considered to be less expensive than the other options. The DEIS goes on to indicate that the chief problem with this method is that there is a lack of assurance that funds will be available to pay for decommissioning in the event of a premature closing. As a result, the suggestion is made that this method could only be applied if it were supplemented by substantial additional financing mechanisms such as prepayment, insurance, or a surety bond. Although the concern about a premature closing is generally valid, the concern should not be extended so as to establish financial assurance requirements on the assumption that each and every nuclear power plant would be subjected to premature closing. Based on the established operating history of nuclear power plants, it is unlikely that more than a very small number of nuclear power plants would be closed prematurely.

As to the few plants which may be closed prematurely because of an accident, the costs of cleanup would likely far exceed the costs of decommissioning. If the costs of cleanup can be met, the costs of decommissioning probably can too. As a practical matter, the magnitude of cleanup and decommissioning costs (in addition to other costs of an accident) is so great that such costs probably can be addressed only on an industry-wide insurance program basis. Under such circumstances, it is improper to treat accident-caused decommissioning in the same manner as normal end-of-life retirement.

Very truly yours,

E. E. Van Brunt

E. E. Van Brunt, Jr.
Vice President
Nuclear Projects Management

EEVB:jaw

cc: H. B. Sargent
T. G. Woods
G. C. Andognini
O. M. DeMichele
A. C. Gehr
J. M. Allen
A. C. Rogers
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Department of Energy
Washington, D.C. 20585

Docketed
USNRC
JUN 24 1981
Office of the Sec.
Docketing & Ser.
Branch
mdv

JUN 22 1981

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,72 (30)
(46 FR 11666)

Mr. S. Chilk
Docketing Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Chilk:

The Nuclear Regulatory Commission document NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities" January 1981, has been reviewed by the Department of Energy staff and their general and specific comments are furnished in the two enclosures for your consideration in preparing the final statement.

If you have any questions on this matter, please contact Dr. Cooperstein of my staff on 301-353-3639.

Sincerely,

Barton R. House

Barton R. House
Acting Assistant Secretary for
Environmental Protection,
Safety, and Emergency Preparedness

2 Enclosures

Acknowledged by card. 6/24/81. mdv

GENERAL COMMENTS ON DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT ON DECOMMISSIONING OF NUCLEAR FACILITIES

1. In view of the amount of time, effort and money expended in producing this document, it is disturbing that the product exhibits a number of inconsistencies, is incomplete in some instances and inordinately addresses topics that are extraneous to environmental issues, e.g., financial surety for decontamination and decommissioning activities.

2. Decommissioning, as defined, is too restrictive and appears to favor the DECON option. It is not clear that unrestricted use of property following decommissioning should be a requirement, particularly if other nuclear facilities are operational on the site.

3. The information base has voids in it as exemplified by uncompleted supportive detailed technical reports on some of the steps in the nuclear fuel cycle. Thereby, the required safety and cost evaluations can only be considered as preliminary in nature. Further, the cost figures should be included in the overview section of the document.

4. Although the report is prepared as an information document for the public and summarizes the ongoing characterization and decontamination and decommissioning requirements for Nuclear Regulatory Commission-licensed fuel cycle facilities, it should contain enough technical detail to provide salient findings from decontamination and decommissioning performances. This is lacking in the text. Instead, very general terms are employed with little support given for the assertions extracted from the referenced contractor reports. Minimal historical records and actual performances are referred to in the text.

5. The estimated costs and environmental effects for the various decommissioning options for the fuel cycle facilities and reactors discussed in the document are more uncertain than is apparent in the results that are presented. Estimates of uncertainty should be included.

6. The decommissioning options considered are defined at least 15 times throughout the text and make up about 30 pages of the text needlessly.

7. The point at which decommissioning starts should be specified for each nuclear facility, e.g., decommissioning for a reactor would start after all fuel had been removed from the core and storage facilities, etc.

8. Sections 4 through 14 are needlessly repetitious of the earlier sections. Combining the two major parts of the document would better serve the purpose of the document.

9. The experience in dismantling the Elk River reactor is discussed repeatedly while experiences in decommissioning other nuclear facilities are barely mentioned.

10. The criteria for the ENTOMB option should be based on radiation exposure levels and not on half-lives of specific radionuclides or institutional controls.

11. Some sections of the document are so inexactly written as to make the entire effort subject to question. For example, the ENTOMB alternative is described as applying only in cases where residual activity will decay to unrestricted use levels in approximately 100 years or less. After indicating that this is not viable for facilities contaminated with radionuclides having half-lives in excess of 100 years, the authors continue by claiming viability for cases where the entombing structure will last many half-lives of the "most objectionable long-lived isotope."

12. The rationale for a proposed 1 to 10 mrem/year residual limit and a requirement for "in all cases a dose limit above 1 mrem/year would require justification" is difficult to comprehend in view of the lack of credible discussion and the following points:

    o The last paragraph of page O-7 states "Survey costs are expected to be small in comparison to the overall decommissioning costs, and decontamination costs are essentially independent of the level to which it must be decontaminated as long as that level is in the range of 1 to 25 mrem/year to an exposed individual." This is contrary to the Department of Energy's experiences.

    o The statement on page 8 of NUREG-0590, "Thoughts on Regulation Changes for Decommissioning," authored by one of the document's preparers, declares that a terminal radiation survey with reasonable confidence and moderate cost could be achieved at the 5 mrem/year level. It continues with the statement "It was found that the cost as a release level of 1 mrem/year would be extremely high and not easily estimated." These statements are inconsistent with the above rationale.

    o A selected residual radioactivity limit must be safe, consistent with existing regulations and the ALARA principle, and verifiable through detailed survey measurements.

    o Due to the variety of facility types and radionuclides involved, it does not seem feasible to set a single dose limit that would be valid under all conditions for all facilities. It is necessary to assess the radiological impact in terms of the radionuclides and pathways involved and the <u>costs</u> and <u>benefits</u> which result.

    o Environmental Protection Agency radiation protection standards for nuclear power operations (40 Code of Federal Regulations 190; 42 Federal Register 2858, January 13, 1977) requires "reasonable assurance provisions that the annual dose equivalent <u>does not exceed 25 mrems to the whole body</u>, 75 mrems to the thyroid, and <u>25 mrems to any other organ of any member of the public</u> as a result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations."

13. The Nuclear Regulatory Commission's responsibilities include licensing and regulatory actions for commercial nuclear fuel cycle facilities. The financial capability of a licensee to decontaminate and decommission his facility in order to terminate his license should be a condition of the license. Detailed discussions on fiscal responsibility and alternative funding methods can hardly be classified as an environmental issue.

14. The "No Action" alternative is dismissed as not viable for all facilities discussed since a final (terminal) radiological survey and report are required, at the least. This too should be considered as a license condition and seems inappropriate for protracted discussion in an environmental impact statement. A discussion of the certification procedure to establish the compliability of the facility, following decontamination and decommissioning activities with established standards and criteria would be more meaningful and appropriate in the document.

15. The use of a standard areal site size for all fuel cycle step facilities is not valid based on the existing situations. It can readily result in misconceptions and misleading conclusions concerning land use for waste management activities and recoverable land areas for future appropriate uses.

16. The overall impacts of wastes from decommissioning activities on operating nuclear waste disposal sites suffers from a paucity of discussion in the document. Especially from the standpoint of the impact that variations in the residual radioactivity criteria may have on projected waste volumes.

17. In addition, the possibility of decommissioning a facility when no viable option for waste disposal is available should be addressed, e.g., for decommissioning a facility involving TRU or special nuclear material wastes. In view of this situation, item 14 above could also imply that the licensee could be required to maintain his license, unwillingly, beyond his desired termination point because of an inability to adequately manage the projected generated wastes.

In summary, (1) the analyses of the matter are not diligently pursued, (2) the review is in very large part based on records only recently provided by Pacific Northwest Laboratories, (3) contains excessive duplication of statements, and (4) includes conflicting information thereby negating Council on Environmental Quality regulations (40 Code of Federal Regulations 150-8 and Executive Order 12291) which are intended to ensure well-reasoned regulatory actions.

The authors are encouraged to review the document and references for consistency. There are too many cases which are self-contradicting or subject to misinterpretations which may lead to questioning the validity of the document. The document also includes many side issues (license conditions or requirements) which are beyond the scope of the impact statement's requirements as listed on page 1-2, paragraph 1.1.1. A shorter, internally consistent document should fulfill the National Environmental Policy Act process.

SPECIFIC COMMENTS ON DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT ON DECOMMISSIONING OF NUCLEAR FACILITIES

1. Page iv, 1st paragraph, line 2: "Desired objective" should read "required objective."

2. Page v, 1st paragraph, line 2: "Included" should read "addressed."

3. Page v, 2nd paragraph, last line: Delete last sentence.

4. Page v, 4th paragraph, line 2: Add "decontamination and" after "requires."

5. Pages v and vi, 1st and 5th paragraphs: Define what year's dollars are involved in funding mechanisms. The estimated cost of decommissioning could be based on (a) today's dollars; (b) dollars 30-40 years from now; (c) specific inflation factors. Unless assumptions are well-defined, estimates may be worthless.

6. Page vi, 2nd paragraph: "Planning" may at least be an "outline plan."

7. Page vi, 2nd paragraph, line 8: Cost/benefit analysis is essential.

8. Page vi, last paragraph: Inconsistent--see General Comment #12. Loosely written for regulatory criteria. Potentially counterproductive. "ALARA" includes taking into account economics of improvement in relation to benefits to the public health and safety.

9. Page vii, 4th paragraph, line 11: Costs discussed are strictly an unknown.

10. Page 0-1, last paragraph, line 3: Why postulate an accident when there has been one?

11. Page 0-4, lines 14-16: Recommend revising this definition--deleting references to unrestricted use of property and adding references to protecting public health and safety.

12. Page 0-4, last paragraph, lines 3 and 4: It is more appropriate to issue a new license.

13. Page 0-5, 1st paragraph, line 1: Insert "licensed" before "radioactive facility."

14. Page 0-5, 2nd paragraph, last line: Provide basis for estimated time.

15. Page 0-6, last paragraph: See General Comment #12.

16. Page 0-7, line 18: Change "ingestion pathway" to "ingestion and inhalation pathway."

17. Page 0-7, lines 28 and 29: This limiting case ("housing development... constructed on the site...) is too restrictive. Most nuclear power plants and related facilities are located in remote, sparsely populated areas. Farming would be a much more likely use of the land after decommissioning.

18. Page 0-7, last paragraph: Supporting evidence for decontamination costs claimed is warranted here.

19. Page 0-9, lines 7-9: This consideration is not realistic and could result in misleading conclusions.

20. Page 0-9, lines 34-37: The Elk River reactor was a BWR, not a PWR. It should not be discussed under PWR decommissioning experience.

21. Page 0-11, lines 8 and 9: The locations at which these dose rates are measured should be specified (e.g., 1 foot from internals).

22. Page 0-13, line 1: Actual measurements should be used rather than calculations.

23. Page 0-13, lines 4 and 5: These lines are not too understandable.

24. Page 0-14, line 9: Costs should be updated.

25. Page 0-16, line 7: The 1160-acre reference site is questionable based on actual reactor site values.

26. Page 0-22, line 3 and ff: Cost for MOX ENTOMB should be included for completeness.

27. Page 0-24, line 4: Currently there are two licensed conversion plants.

28. Page 0-25, lines 5 and 6 from bottom of page: The statement is questionable based on Department of Energy remedial action experience.

29. Page 0-26, line 20: Reference should be cited.

30. Page 0-27, line 10: The statement "...the CaF_2 would then be disposed of by the new owner" should be elaborated upon.

31. Page 0-28, line 19: The caustic nature of CaF_2 is questioned.

32. Page 0-29, line 19: Add "from compromised fuel elements" after "fission products."

33. Page 0-29, lines 22 and 23: The substantial differences in inventories should be illustrated.

34. Page 0-29, lines 25-28: Describes an atypical fuel element situation, i.e., metallic fuel elements rather than oxide fuel elements.

35. Page 0-29, next-to-last line: This line discusses low radiation fields, but on page 0-30, lines 25-27 describe an inverse situation.

36. Page 0-32, line 1 and following: This should be referenced. It cannot readily be visualized that 40 power plants, 2 ISFSI's and facilities suitable for disposal of 3.2 million m^3 of radioactive waste (high- and low-level) could practically be located in a nuclear energy center.

37. Page 0-33, last line of page: Discuss the basis for the need of surveillance and maintenance during ENTOMB in perpetuity.

38. Page 0-34, line 11: Provide reference and discuss the basis for this statement.

39. Page 0-34, lines 20 and 26: There appears to be an inconsistency in the number of non-fuel-cycle nuclear facilities.

40. Page 0-35, lines 7 and 8: Tin slag cannot be classified as an ore; "large volumes" should be quantified.

41. Page 0-36, last paragraph: Residues should comply with the Environmental Protection Agency's 40 Code of Federal Regulations 192 requirements and the Nuclear Regulatory Commission's regulations resulting from the generic milling study.

42. Page 0-38, lines 5 and 6: Discuss the basis for the statement of concern.

43. Page 0-38, line 15: This statement is inconsistent with the GEIS on milling.

44. Page 0-38, lines 21 and 24: "Desired" should read "required."

45. Page 0-39, lines 15 and 16: An upper limit for the life of an entombment structure would depend upon the design of the structure. It would not necessarily be 100 years (the period of expected institutional control).

46. Page 0-39, line 19: Explain this statement.

47. Page 0-40, lines 1-12: The choice of decommissioning alternatives should be based on protecting public health and safety (i.e., meeting radiation exposure limits) not on the half-lives of the "critical/abundant" radionuclides. In other words, the classification scheme (based on half-lives of 5, 30 and greater than 30 years) is pointless.

48. Page 0-45, Table 0.0-2: MOX to ENTOMB should also be estimated.

49. Page 1-3, lines 16-19: See Comment #11.

50. Page 1-5, line 5: Insert "currently" before "licensed by NRC."

51. Page 1-5, last sentence: Should be deleted; this is addressed in the GEIS on milling.

52. Page 1-7: The table should note that these facilities were not licensed.

53. Page 2-1, line 26: Insert "primarily" before "sedimentary deposits..."

54. Page 2-4, lines 25-27: See Comment #11.

55. Page 2-7, line 31: Define "[temporary entombment]."

56. Page 2-7, lines 23-27: ENTOMB should be a viable alternative if the entombment structure can last until radiation exposures would be $\leq$ 10 mrem/year (not "if the entombing structure can be expected to last many half-lives of the most objectionable long-lived isotope").

57. Page 2-10, lines 3 and 4: The ALARA definition is incomplete.

58. Page 2-10, 3rd paragraph and last numbered lines on page: Inconsistent.

59. Page 2-11, line 23: The risk for a one rem dose should be about 2 x 10^{-4}(BEIR III), not 1 x 10^{-4}.

60. Page 2-11, lines 22-30: The noted risks should be stated as annual risks.

61. Page 2-12, 2nd paragraph: Should discuss concomitant resultant decreases in potential health effects that would be achieved via these reductions in exposure levels and costs.

62. Page 2-13, lines 14 and 15: Compare this statement with the Environmental Protection Agency's 40 Code of Federal Regulations 190.

63. Page 2-14, line 7: Should specify if dose rate value includes background.

64. Page 2-14, line 15: "Certification survey" should be described.

65. Page 2-18, 1st paragraph: Should suffice as discussion of financial assurance in lieu of previous pages.

66. Page 2-18, after line 3 (item 5): Should discuss an item 6, Liquid effluents.

67. Page 2-19, Table 2.6-1: Should be updated from 1977 values; units should be uniform, either volumetric or mass.

68. Page 2-19, 1st paragraph, last line: Add "and potential solutions" after "problems."

69. Page 2-19, 2nd paragraph, last line: Indicate commercial TRU waste locations.

70 Page 3-1, 4th paragraph, lines 1 and 2: Fuel fab and conversion plant site size assumptions are apparently invalid based on existing situations.

71. Page 4-2, lines 15 and 16: See Comment #20.

72. Page 4-3, lines 1-12: See Comment #20.

73. Page 4-4, Tables 4.3-1 and 4.3-2: Values shown should be updated.

74. Page 4-5, line 6: Occupational radiation dose values do not reflect more recent studies.

75. Page 4-9, lines 1 and 2: Should define "extended chemical decontamination and basis for additional costs."

76. Page 4-9, lines 24-26: Describe how an entombed structure could be breached and discuss the likelihood of such an occurrence.

77. Page 4-9, line 31: Describe the difference between restoring things to their original condition and complying with established standards or guidelines.

78. Page 4-10, 2nd paragraph from bottom of page, line 2: Discuss basis for the statement "Total water use for decommissioning should not exceed 18 x $10^3 m^3$."

79. Page 5-4, last paragraph, lines 5-7: In view of institutional control time and half-life expectancies, discuss rationale for statement.

80. Page 5-5, 3rd paragraph from bottom of page: Appears to be inconsistent.

81. Page 5-6, Tables 5.3-1 and 5.3-2: Should be updated to provide more realistic experience data.

82. Page 5-12, 2nd paragraph: Radionuclide half-lives alone are not of primary concern. Their specific activities are a cogent aspect.

83. Page 7-2, lines 5 and 6 from bottom of page: Discuss shipments from FRP to burial grounds.

84. Page 7-3, line 9: In view of Environmental Protection Agency guidance, discuss license to dilute and discharge to a river.

85. Page 7-5, 3rd paragraph, line 2: Explain the expression "risk to safety."

86. Page 10-1, 1st paragraph: Only two licensed conversion plants are in operation.

87. Page 10-5, 3rd paragraph, lines 3 and 4: Cite reference for statement and define "bulk quantities of uranium."

88. Page 10-5, last paragraph, lines 2 and 3: Provide the basis for the stated periodic surveillance frequency proposed.

89. Page 10-6, line 15: Provide reference and basis for statement about removal of buried material.

90. Page 11-2, lines 5 and 6: The statement is allusory; the substance is relatively inert.

91. Page 11-7, line 9 from bottom of page: CaF_2 is a relatively inert compound.

92. Page 12-1, 1st paragraph, line 5: "The Department of Energy" should read "The Nuclear Regulatory Commission."

93. Page 12-1, 2nd paragraph, lines 1-3: Describe the details to be expected in the report based on opening sentence.

94. Page 12-1, 3rd paragraph, line 1: Identify the location(s) that irradiated fuel will be shipped to from an ISFSI.

95. Page 12-4, 2nd paragraph, line 1: Discuss the basis for the statement.

96. Page 12-11, lines 1 and 2: Explain this statement in view of the presumed duration of institutional controls.

97. Page 13-4, lines 1 and 2: The need for unrestricted use at the time and under the prevaling conditions discussed are not consistent.

98. Page 14-4, lines 1 and 2: Provide a justification for the presumptive statement.

99. Page 14-5, paragraphs 3 and 4: Should also address Public Law 95-604.

100. Page 14-10, statement at bottom of page: Appears to be paradoxical in view of the continuing paragraph.

101. Page 15-4, lines 3-39, and Page 15-5, lines 1-3: The choice of decommissioning alternatives should be based on protecting public health and safety, not on the half-lives of radionuclides.

102. Page 15-10, Section 15.2 "Regulations": Should include Parts No. 20, 60, 61 and relevant Environmental Protection Agency regulations.

EDITORIAL COMMENTS

1. Page iii, line 8: Misspelled "separate."

2. Page iv, 3rd paragraph, line 5: Misspelled "hexafluoride."

3. Page vi, 3rd paragraph, line 3: Capitalize "agreement states."

4. Page 0-1, line 31: Add comma after "EIS."

5. Page 0-3, line 1: Capitalize "acts."

6. Page 0-3, line 10: 10 Code of Federal Regulations Chapter I?

7. Page 0-24, last line: "Commissioning" should read "decommissioning."

8. Page 0-32, line 14: "Aveage" should read "average."

9. Page 0-34, line 6: "Very less than" should read "much less than."

10. Page 0-37, line 18: Adjectives/adverbs such as "exhaustive" should be avoided.

11. Page 0-38, line 20: "Agreement state" should be capitalized.

12. Page 0-40, line 5 from bottom: "Aspct" should read "aspect."

13. Page 0-42, line 6: "In chosen" should read "is chosen."

14. Page 1-1, line 24: "Rulemaking" should be "rulemakings."

15. Page 1-3, line 28: Capitalize "acts."

16. Page 1-4, line 6: Capitalize "agreement states."

17. Page 1-5, line 30: Capitalize "federal."

18. Page 1-6, footnote (c): Capitalize "agreement states."

19. Page 2-9, line 10: Capitalize "agreement states."

20. Page 2-12, line 3: "Useage" should read "usage."

21. Page 2-16, lines 16 and 21: "Suretys" should read "sureties."

22. Page 2-17, line 22: "Mill" should read "mil."

23. Page 2-18, lines 10 and 11: Delete "include."

24. Page 2-18, lines 27 and 29: Delete "mine and."

25. Page 4-8, Table 4.3-3: Should be referenced; missing values should be discussed.

26. Page 5-1, 2nd paragraph from bottom, line 5: "Secndary" should read "secondary."

27. Page 6-1, 1st paragraph, line 2: "Conclusion" should read "conclusions."

28. Page 7-4, 2nd paragraph, last line: Table reference is incorrect.

29. Page 7-5, last paragraph, line 1: There is no Section 2.3.2.

30. Page 7-8, last paragraph, line 3: After "...a license..." insert "must be."

31. Page 7-13, Table 7.4-1: Should be referenced.

32. Page 8-7, Table 8.3-3: Title of Table should have superscript (a) after it.

33. Page 11-2, lines 10 and 11: "Plant" should be lower case.

34. Page 11-7, Table 11.3-4, footnote (c): "CaF^2" should read "CaF_2."

35. Page 14-1, 2nd paragraph, line 2: Capitalize "agreement states."

36. Page 14-1, 3rd paragraph, line 1: Capitalize "agreement state."

37. Page 15-1, line 1: Capitalize "agreement state."

38. Page 15-1, line 2: "Desired" should read "required."

39. Page 15-1, line 5: Delete "desired."

40. Page 15-1, line 14: Delete item (4).

41. Page 15-5, line 5 from bottom: "Mimimized" should read "minimized."

42. Page G-2, UF_6: "Hexaflouride" should read "hexafluoride."

43. Page G-2, Burial Grounds: "Storage" should read "disposal."

44. Page G-8, Solid Radioactive Waste: "Contained" should read "contain."

45. Page G-8, Termination Radiation Survey: "Near the end" should read "following."

K. Steyer

health industry manufacturers association

1030 15th street nw • washington dc 20005 • 202/452-82

(31)

DOCKET NUMBER
PROPOSED RULE PR-30, 40, 50, 70, 72
(46 FR 11666)

Docketed
USNRC

Office of the Sec.

mdv

June 5, 1981

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attention: Docket and Service Branch

Dear Secretary:

Enclosed, please find an original and four copies of comments from the Health Industry Manufacturers Association (HIMA) concerning the NRC's Draft Generic Environmental Impact Statement on the Decommissioning Criteria for Nuclear Facilities.

Very truly yours,

Howard M. Holstein

Howard M. Holstein
Vice President and General Counsel

Acknowledged by card 6/30/81 mdv

President
Harold C. Buzzell

health industry
manufacturers
association

1030 15th street nw • washington dc 20005 • 202 452-8

June 5, 1981

Docketed
USNRC
JUN 30 1981
Office of the Sec.
Docketing & Ser.
Branch

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Docketing and Service Branch

Subject: Docket No. 81-4626
Decommissioning Criteria for Nuclear Facilities; Notice of Availability of Draft Generic Environmental Impact Statement

Dear Secretary:

The Health Industry Manufacturers Association (HIMA) herein submits its comments on the Draft Generic Environmental Impact Statement (GEIS) prepared by the Nuclear Regulatory Commission (NRC) in anticipation of proposed regulations governing the decommissioning of nuclear facilities.

I. GENERAL COMMENTS

HIMA is a national trade association that represents 256 manufacturers of medical devices and diagnostic products, some of whom are licensed radiopharmaceutical manufacturers. For the most part, nuclear material used by HIMA members has relatively short half lives and is used to produce *in vitro* diagnostic products that are essential to health care in the United States.

The Association welcomes the opportunity to participate in the comment process. A review of the GEIS demonstrates the NRC's concern with environmental standards that must be met when nuclear facilities are decommissioned. We share that concern. However, we believe that the approach envisioned by the GEIS is overly burdensome as it relates to non-fuel cycle, radiopharmaceutical, medical research and development, and clinical laboratory facilities. Procedures and rules that may be necessary or appropriate for facilities such as nuclear power plants, are not appropriate for health care manufacturers.

II. SPECIFIC COMMENTS

A. NRC's Decommissioning Activities are Premature.

As Section 2.5.1 of the GEIS recognizes, the Energy Reorganization Act of 1974 gives the Environmental Protection Agency (EPA) responsibility for establishing radiation dose standards for protection of the public health and safety. Thus, it is up to EPA to develop criteria for residual radioactivity limits considered safe for decommissioning a nuclear facility to permit unrestricted access. That criteria is not scheduled to be established by EPA until 1984.

Until criteria exist, NRC is not in a position to determine what changes, if any, are required in the Commission's present decommissioning standards. If NRC establishes revised decommissioning standards now, it is quite possible that once EPA sets the residual radioactive criteria for unrestricted access, the Commission will be required to revise its regulations.

Accordingly, HIMA urges the NRC to follow the sequence of events outlined below for revising its decommissioning standards.

- First, let EPA establish the residual radioactivity criteria for unlimited access to decommissioned nuclear facilities.
- Second, the NRC should determine what changes, if any, are required in its decommissioning standards in order to assure that decommissioned nuclear facilities meet EPA's criteria for unlimited access.
- Finally, NRC should issue a proposal to implement the required changes.

This course of action is reasonable and proper, especially since no need has been demonstrated for NRC to revise its decommissioning rules before EPA establishes the underlying criteria. In view of the Reagan Administration's concerns with the proliferation of unnecessary and inflationary regulations, this sequence of events is particularly appropriate.

B. Regulations Anticipated by the GEIS are Overly Burdensome for Radiopharmaceutical, Medical Research and Development, and Clinical Laboratory Facilities.

The GEIS was prepared as part of the requirement for changing regulations on decommissioning both fuel cycle and non-fuel cycle commercial nuclear facilities.

The regulations contemplated by this GEIS would, among other things, require each nuclear facility licensee to provide financial assurance to the NRC that adequate funds are available for decommissioning its facility. In addition, the nuclear facility licensee would be required to submit a decommissioning plan with its initial license application. This plan would thereafter be updated periodically.

While these requirements may be reasonable for decommissioning nuclear fuel cycle facilities, the data demonstrate that the requirements are overly burdensome, unreasonable, and too costly for non-fuel cycle facilities engaged in the radiopharmaceutical, medical research and development, and clinical laboratory industry.

Table 0.0-2 of the GEIS provides a summary of estimated costs for decommissioning nuclear fuel cycle facilities. These costs range from $2.3 million for decontaminating a UF_6 Conversion Plant by the DECON method to $167.0 million for decontaminating a fuel processing plant by the SAFSTOR method for a 100 year period.

Table 14.3-1 of the GEIS estimates the cost of decontaminating a radiopharmaceutical facility to be significantly lower. These costs are estimated by NRC to range from $3,540 for the simple decommissioning of a laboratory area 20' x 20' with low-level contamination used for amino acid syntheses to $14,178 for the difficult decommissioning of a gamma lab with a hot cell. These costs are on the order of 100 to 55,000 times lower than the estimated cost for decommissioning a fuel cycle facility.

Practical reasons for this very significant difference exist. Nuclear fuel cycle facilities are large installations that handle considerable quantities of radioisotopes with long half lives and they require extensive decontamination efforts. The cost of decontaminating one of these facilities may be far in excess of the value of the facility once it is decontaminated. Under these circumstances, it may be reasonable and in the public interest to require the licensee to provide financial assurance of the availability of adequate decommissioning funds. Furthermore, since these facilities handle radioisotopes with long half lives, it seems reasonable to require them to submit initial and updated decommissioning plans.

Conversely, radiopharmaceutical, medical research and development, and clinical laboratory facilities are usually small installations that use relatively low levels of radioisotopes, many of which have extremely short half lives often measured in days, not years. The efforts required to decontaminate one of these facilities are minimal. Further, the cost of decontaminating, as evidenced in Table 14.3-1 of the GEIS, is significantly less than the value of the facility once decontamination is completed. Because of their underlying value, these facilities would be economically salvaged by decontamination without additional financial guarantees. Furthermore, due to the short half life of many of the radioisotopes used by these facilities, decommissioning could be concluded very quickly, generally through the DECON method.

Since the expense involved in decommissioning a radiopharmaceutical, research and development, or clinical laboratory facility is both minimal and substantially less than the value of the facility being cleaned, it is quite apparent licensees will want to decommission a facility once the licensed operations cease. No public benefit would be served, and no additional incentive would be provided, by requiring these facilities to incur an unnecessary expense by providing assurances of the financial ability to decommission. Similarly, since these facilities can be decommissioned very quickly, no public interest would be served by requiring them to file initial or updated decommissioning plans. This too would result in an unjustified expense.

III. CONCLUSION

When the NRC issues the proposal contemplated by this GEIS, we urge it to exclude radiopharmaceutical, medical research and development, and clinical laboratory facilities from being required to provide financial assurances for decommissioning and from submitting decommissioning plans. We think the regulatory approach presently contained in NRC's June 1980 guidelines for decommissioning provide important public benefit and should continue to be followed by NRC with respect to the decommissioning of radiopharmaceutical, medical research and development, and clinical laboratory facilities.

Thank you for the opportunity to comment. HIMA would be pleased to provide you with additional information or to discuss these comments with you at your convenience.

Very truly yours,

Hal Buzzell

Harold O. Buzzell
President

3164 Main Street ; Buffalo, New York 14214 (716) 832-9100

(32)

DOCKET NUMBER
PROPOSED RULE PR-30, 40, 50, 70, 72 (46 FR 11666

COMMENTS ON NUREG-0586
DGEIS ON DECOMMISSIONING NUCLEAR FACILITIES
by
SIERRA CLUB RADIOACTIVE WASTE CAMPAIGN
May 25, 1981

The Sierra Club Radioactive Waste Campaign supports the policy and regulatory objectives of the DGEIS on decommissioning nuclear facilities. These objectives are 1)timeliness, terminating the license in a timely manner, 2) financial assurance, assuring that funds are available at any time during facility operation, 3) planning, registering a plan with detailed cost and method of funding, with an emphasis on health and safety rather than economics, and 4) residual radioactivity levels below 10 mr/year whole body dose. While we agree with these general regulatory objectives, they are essentially empty without accompanying proposed regulations. Further, because they are based on idealized facilities rather than real operating experience, and because improper definitions are employed, realization of the objectives will fall short of the mark.

The Sierra Club Radioactive Waste Campaign is an educational and organizing component of the Sierra Club, an environmental organization with over 200,000 members. The Radioactive Waste Campaign has had experience in reviewing the decommissioning plans of the West Valley defunct reprocessing plant, high level waste tanks and burial grounds, numerous Manhattan Project sites in NY, NJ and PA, and several reactor decommissionings. Our experience with these sites and the citizens who live in the vicinity provides an understanding of the real problems associated with decommissioning.

Docketed
USNRC
JUL 10 1981
Office of the Sec.
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sierra club
radioactive waste
campaign

3164 Main Street Buffalo, New York 14214 (716) 832-9100

May 26, 1981

G. Donald Calkins
Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
US Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Calkins:

Enclosed are the comments of the Sierra Club Radioactive Waste Campaign on NUREG-0586, DGEIS on Decommissioning Nuclear Facilities. We hope that these comments are useful for your purposes.

We would greatly appreciate it if you could send us two documents published by the NRC:

GD Calkins, Draft Thoughts on Regulation Changes for Decommissioning, NUREG-0590, Rev.2, August, 1980

Robert S. Wood, Assuring the Availability of Funds for Decommissioning Nuclear Facilities, Draft Report, NUREG-0584, Rev.2, October, 1980.

If a final version of these reports is available, we would appreciate receiving copies. We have copies of the other decom reports for specific types of facilities. Thank you for your help.

Sincerely,

Marvin Resnikoff, staff scientist

sierra club
radioactive waste
campaign

The Club supports the general regulatory objectives of timeliness, financial assurance, planning and the residual radioactivity levels. We agree with the purposes of decommissioning, to provide unrestricted use of a site or facility at the earlist possible time (p.0-39). We agree with the objective of funding mechanisms to "ensure that adequate funds are available to decommission" (p.0-40), and to assure that the "funds for the full costs of decommissioning (are) available at any time during facility operation". In ensuring that funds will be available, the Staff is thereby assuring that the public health and safety will be protected at any time.

Unfortunately there is no assurance that these regulatory objectives will be met because no regulations have been proposed to accompany this DGEIS. This is an important omission.

Decommissioning funds must be available under all circumstances, accident, premature closing (non-accident), and normal operations. Funds for decommissioning are collected during operation of the facility and must accomodate different ranges of decommissioning costs, and be collected during periods of operation. In the case of a reactor, the facility may operate for three months, or thirty years; the costs to decommission may be $40 million in todays dollars, or $1 billion. Normal operations and decommissioning costs may be able to be predicted. Inflation rates, interest rates, costs of decommissioning and waste disposal, and cooldown period may be predicted. The funds would be collected during the operation period of a reactor, say 30 years. We strongly support the Staff's position that plans and detailed cost estimates be predicted at the time the reactor goes into operation. This would allow Public Utility Commissions to predict rate structures. Since funds set aside during the 30 year operational period must be available 60 years after reactor start-up, these plans must be well detailed.

The costs to decommission a facility following an accident can be quite large, equalling the initial construction costs perhaps. The period for collection of these funds may be as short as three months. It is therefore impossible for a single reactor to generate sufficient funds at any time during operation to pay for decommissioning due to an accident. This would double the cost of nuclear power generation if sufficient capital were to be set aside. There is therefore a need for a private insurance arrangement between all utilities operating reactors. The Staff and the NRC Commissioners should recommend legislation which requires this private insurance in order for a reactor to obtain an operating license. Operating licenses should be terminated without this insurance. Accident insurance could be independent of a separate decommissioning fund for "normal" decommissioning. We agree with the Staff that an internal reserve, or negative salvage value arrangement would not provide the assurance required since the funds would not be liquid and available when needed. Instead, we believe that liquid funds must be placed in a separate account which is under the jurisdiction of the separate states where the reactors are located. Since the states, not the Federal Government, are ultimately disadvantaged by decommissioning mismanagement, the states ought to supervise the decommissioning account.

It is important to note that premature closure of a facility may not be due to an accident, but to faulty design. For example, Indian Point-1 had an inadequate emergency core cooling system. The plant operated for only 12 years. Insufficient funds for decommissioning were collected from the users of IP-1 electricity.

We support the regulatory objective of prompt NRC termination of a license. As far as funding availability, and corporate accountability is concerned, this is absolutely essential. The longer the decommissioning period, the less likely it will be that corporations will be viable and that funds will be adequate. Inflation and interest rates cannot be predicted. There is an important trade-off between "safe" funds, which do not match the inflation rate and less safe funds, such as money market accounts. The latter is more volatile than government securities. There is a balance here and it is difficult to judge the most advantageous. The longer into the future decommissioning is postponed, the more likely it will be that the decommissioning uncertainties will increase, and the more likely that a corporation will not be available to do the decommissioning. We therefore support the concept of performing the decommissioning as soon as possible consistent with health and safety. For a reactor, the Staff has indicated that this would not be greater than 30 years after closure.

We support the Staff on residual radioactivity levels of at most 1 - 10 mrem/year whole body dose. However, we differ with Staff greatly on how this dose should be calculated and what "whole body dose" means. The Staff appears to be moving away from the old concept of "unrestricted release" of a facility. By"unrestructed release" we mean that doses are calculated as iff a person were to reside 24 hours in the presence of the radioactivity. That type of calculation was conservative and proper since the NRC Staff were obviously not going to police every type of activity which might take place around a SAFSTOR facility. Instead, the Staff now intends to use "realistic" pathway analyses to calculate dose. Such an analysis might include a housing project located onsite next to the "stored" reactor. But this would include the possibility that children could burrow into the reactor, or does the Staff assume that the utility will safeguard a useless hunk of metal with the same diligence as it exercised during full operation? In other words, does the Staff assume all possible and credible means of radiation exposure to the population, or will it select a subset? If a subset, the Staff must then devise procedures and regulations to ensure that this subset will not be enlarged. Our experience indicates that these facilities will be protected less and less with time. Information is lost and diligence wanes. Successive generations of guards begin to lose their purpose; security becomes lax.

On the other hand, a local community's interest in removing an unproductive piece of land and returning it to the tax base increases over time. The benefits of electricity production and tax base long since past, the reactor mausoleum becomes only a "cost" in the cost/benefit equation.

We differ with the Staff on the use of ICRP-26 to calculate "whole body dose equivalents". The risk to each separate organ must be calculated. While the ICRP-26 method lends itself to easy calculation, it is not good science. It should not replace a detailed pathway model to each organ, and to persons of varying susceptability.

Finally, we differ with the Staff on whether "the technology for decommissioning is well in hand", and whether the costs are precisely known. Technology has not been developed to remotely dismantle a nuclear reactor 30 years after operation has ceased. We believe that such remote handling capability could be developed with additional R & D, but it is not "well in hand". Since it is unlikely that the utility nuclear reactor staff will be on-hand to decommission a nuclear reactor, it is more likely that decommissioning contractors will do the work. There is a need for re-usable equipment that can be moved from site to site. It would probably lower decommissioning costs and perhaps the equipment can be built to decommission a reactor with minimal occupational exposures.

The Club also does not believe that it is possible to release a solid radioactive waste burial ground for unrestricted use after 100 years, or whether it is possible to relax surveillance after this period. This is certainly not true for Maxey Flats, West Valley or Sheffield. Attached to these comments is our fact sheet titled, "Insecure Landfills: The West Valley Experence". Each of the above burial grounds has had considerable erosion, water infiltration and radionuclide leakage problems. We believe that the water infiltration into theburial ground at West Valley cannot be halted without a permanent shield to bedrock, or without exhuming the contents of the burial ground and placing the radioactive material in above ground bunkers. Clearly insufficient funds have been collected to maintain these sites in perpetuity. We are coming to the opinion that the original generators of this so-called low level waste material must retain ownership and responsibility of this material in perpetuity. The NRC analysis of the decommissioning of low level waste burial grounds lacks realism. It certainly doesn't deal with the above three "state-of-the-art" waste dumps. Similarly, the Staff analysis for a fuel reprocessing plant is based on idealistic facilities and not West Valley the only commercial reprocessing facility to have operated in the United States. "Hope springs eternal", and the future always seems brighter to the NRC.

PR 30, 40, 50, 70, 72
46 FR 11666
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OFFICE OF THE GOVERNOR

WILLIAM P. CLEMENTS, JR.
GOVERNOR

April 24, 1981

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JUL 10 1981
Office of the Sec.
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Branch
mdv

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Washington, D. C. 20555

Dear Sirs:

The Budget and Planning Office recently conducted a review of the Draft Generic Environmental Impact Statement pertaining to decommissioning of nuclear facilites, prepared by the U. S. Nuclear Regulatory Commission. The State Environmental Impact Statement Identifier Number assigned to the project is 1-02-50-023.

Subsequent to the completion of the review, we have received additional comments. Those comments are enclosed for your information and use.

It is hoped that these delayed comments will be useful to you in your decision-making process on this project. If this office can be of further assistance, please do not hesitate to call.

Sincerely,

F. R. Spies, Manager
General Government Section
Budget and Planning Office

ep

Enclosures: Comments by Texas Department of Health

RECEIVED

APR 22 1981

Budget/Planning

Texas Department of Health

Robert Bernstein, M.D., F.A.C.P.
Commissioner

1100 West 49th Street
Austin Texas 78756
(512) 458-7111

A. M. Donnell, Jr., M.D., M.P.H., F.A.C.P.
Deputy Commissioner

April 16, 1981

Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
P. O. Box 13561, Capitol Station
Austin, Texas 78711

ATTENTION: General Government Section

SUBJECT: Draft Generic Environmental
Impact Statement
Decommissioning of Nuclear Facilities
U.S. Nuclear Regulatory Commission
EIS No. 1-02-50-023

Dear Mr. Wrotenbery:

The subject Draft Generic Environmental Impact Statement on decommissioning of nuclear facilities, as prepared by the U.S. Nuclear Regulatory Commission and dated January 1981, has been reviewed for its public and environmental health implications. As stated in its Abstract, this "statement was prepared as part of the requirement for considering changes in regulations on decommissioning of commercial nuclear facilities (including that occurring following premature closure)."

On page 2-14, in the first paragraph, a decontamination level of 5 μr/hr is used. It is felt that a more realistic/practicable requirement would be for 5 μr/hr above background, inasmuch as the natural activity or background will exceed 5 μr/hr in many areas. It would be unrealistic to attempt to decontaminate an area to levels below that of the natural background.

Although not directly health-related, the following cost-consideration comments are offered:

- The cost of decontamination estimated in the document assumes that the licensee is performing the decontamination. If "another" is engaged to perform the task, the costs could be significantly escalated--perhaps as much as 50 percent.

Mr. Paul T. Wrotenbery
Page Two
April 16, 1981

- National limits for soil contamination should be developed for each isotope before realistic decontamination cost estimates can be made. Texas currently has a set of limits, but they are unique to this State. A copy of Texas methodology is attached for your information.

- On page 0-10 cost estimates for SAFESTOR indicate a cost of $42.8 million in 1978 dollars for 30 year SAFESTOR, but only $41.8 million 1978 dollars for a 100 year SAFESTOR. This would appear to be an error. If not, the method of arriving at these numbers needs to be better explained.

We appreciate the opportunity to review and comment on the subject Draft Generic Environmental Impact Statement.

Sincerely,

G. R. Herzik, Jr., P.E.
Deputy Commissioner for Environmental
and Consumer Health Protection

RLJ/dbs

ccs: Division of Occupational Health
and Radiation Control, TDH
Division of Water Hygiene, TDH
Division of Solid Waste Management, TDH

PR 30, 40, 50, 70, 72
(46 FR 11666) (34)

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OFFICE OF THE SECRETARY
D.C.

PUBLIC SERVICE INDIANA

S. W Shields
Senior Vice President - Nuclear Division

April 30, 1981

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USNRC
JUL 10 1981
Office of the Sec.
Docketing & Ser.
Branch
mdv

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Sir:

Per the Federal Register, February 10, 1981 (44 FR 11666) the Nuclear Regulatory Commission staff solicited comments on the document NUREG-0586 "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities." Public Service Company of Indiana, Inc. (PSI) comments are attached to this letter. They are for the most part specific to nuclear generating stations, however we feel they can probably be generally applied to each type of facility within the NUREG's scope.

As you will find when reading our comments, PSI does not agree with the NUREG's recommendations that new decommissioning regulatory guidance is needed. We conclude this from the same technology data base that is presented in the NUREG, plus a concern about possible NRC pre-emption of other governmental agencies' authorities. Basically, the NUREG does not adequately address the relative impact (costs/benefits) of new regulations versus maintaining regulatory status quo. The document is therefore deficient as an Environmental Impact Statement and does not represent an adequate base for the proposed regulations.

Another concern that we have deals with the costs to the consumer that would result from the potential regulations discussed in the report. They would for the most part be inflationary, and we believe these costs would not be accompanied by any significant improvements from a public health and safety standpoint.

If the recommended regulations are to be further considered, a cost/benefit/impact type study incorporating these and similar concerns would be in order.

Sincerely,

S W Shields

S. W. Shields

8105180397

RSW/gb
Attachment

P. O. Box 190, New Washington, Indiana 47162

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812 .. 289 . 1000

ATTACHMENT I

PUBLIC SERVICE COMPANY OF INDIANA, INC.
COMMENTS ON NUREG-0586

GENERAL

1) There are several conclusions within NUREG-0586 that Public Service Company of Indiana, Inc. (PSI) is in concurrence with. In Attachment II we bring some of these conclusions to your attention. However, we also note that there are several statements, conclusions, and recommendations that PSI disagrees with. The remaining general comments deal with these.

2) PSI notes that the NUREG's abstract (p. iii) states that "Mitigation of potential health, safety, and environmental impacts requires more specific and detailed regulatory guidance than is currently available." Similar statements are dispersed throughout the NUREG. To be sure, health, safety, and environmental impacts are a major concern in decommissioning as well as in operating nuclear power plants, however, PSI cannot find anywhere in the document where evidence is given to support the notion that new regulations are needed. An argument for additional regulations should justify the accompanying costs (time, money, and limits on future flexibility) with respect to the impacts of maintaining regulatory status quo. The draft Generic Environmental Impact Statement (GEIS) does not do this.

   The statements in Attachment II, plus the history of previous decommissioning activities* support PSI's position on this matter.

3) The draft GEIS recommends regulations to accommodate better initial planning for decommissioning to consist of three elements: Selection of the decommissioning alternative, facilitation and operational considerations ("such as periodic decontamination of coolant crud buildup," p. 15-5), and good record keeping.

   With respect to choosing the decommissioning alternative (DECON, SAFSTOR, or ENTOMB) prior to commissioning, PSI believes there are too many varying factors at this time to appropriately do this for a period of time approximately 40 years from the time of assessment. The NUREG supports this by listing "technology advances, changing regulatory requirements, economics, political climate," (p.15-5) and the relative benefits/impacts of the three options as variables. PSI also notes that the NUREG favors the DECON option, but additionally states that final plans should also "realistically assess the availability of permanent waste burial grounds" (p. 15-6). Today's lack of a high-level waste repository essentially eliminates the DECON option, and this may be the case for 15 or more years.

---

* The previous decommissioning history, per the NUREG: "Since 1960, five licensed nuclear power reactors, four demonstration reactors and six licensed test reactors have been decommissioned." p. 0-3.

On the other hand, PSI believes that the NUREG adequately addresses the three decommissioning alternatives' costs and impacts so that a conclusion can be safely made that initial planning need not include a selection of the particular alternative.

Regarding facilitation of decommissioning through early design and operational considerations, PSI notes that the NUREG adds that some aspects "of decommissioning facilitation (such as those that have impact on reducing occupational dose during facility operation) can reduce operational costs" (p. vi). It is PSI's position that additional regulatory guidance in this area would not be appropriate. "ALARA" regulations that are meant to regulate occupational exposure already exist. Other activities that might be an outcome of this topic, if genuinely cost-worthy, should be considered as prudent management and do not need regulatory assistance.

Recordkeeping which would facilitate decommissioning by reducing costs and/or radiation exposure should also be considered prudent management, therefore additional regulatory guidance is not needed, at least without an assessment of the inadequacies, if any, of current recordkeeping methodologies.

Though we are not sure of the value of additional NRC-funded studies on decommissioning technology (the near-term candidates will soon be adding to the technology base), new information should continue to be disseminated throughout the industry as it becomes available.

4) New regulations to define required final decommissioning planning are also proposed in the NUREG, to entail: Choice of the decommissioning alternative, detailed schedules, administrative controls (such as aspects of the QA program), specifications, and training. Again, PSI concludes that existing regulations are more than adequate in mandating that decommissioning candidates make such commitments. The reasons for this are essentially the same as in comment Number 3 above, including prudent management (very few reactor operators will voluntarily absorb the continuing costs in maintaining an NRC license for a non-productive facility).

5) The NUREG recommends regulations for the establishment of residual radioactivity levels.

PSI does not offer technical comments at this time on suggested dose rates as discussed in the NUREG. However, we do concur with what we understand the philosophy of the discussion to be (ALARA).

Although residual radioactivity levels may well be worthy for regulatory considerations in the future, PSI does not believe it would be appropriate or necessary for NRC to do so at this time: Of the three possible decommissioning options, residual radioactivity levels will only be useful when removing virtually all radioactive materials from the plant site, including high-level wastes. However, since no high-level waste repositories currently exist, ultimate decommissioning cannot occur. Regulated residual radioactivity levels will not be useful until high-level waste disposal sites exist. Regulations providing such will not be productive at this time.

6) The draft GEIS references types of mechanisms for financial assurance of decommissioning.

PSI notes that the House of Representatives is considering the topic (HRs 1814 and 2512), as has the Nuclear Safety Oversight Committee (Reference: Letter, NSOC to President Reagan, dated February 12, 1981), DOE, GAO, various industry groups, and of course NRC. In Indiana, the Indiana State Senate considered a bill (#352, which did not pass), that would have provided financial assurance via a means similar to the method described in NUREG-0586 as "external sinking fund."

In the final analysis, PSI believes that the choice of financial assurance will become a subjective matter. The obvious consideration is how much assurance is desired, weighed against the costs of that assurance and its perceived incremental public health and safety impacts (with respect to some lesser assurance).

It is PSI's position that NRC regulations pertaining to financial assurance, in addition to the existing financial assurance regulations, are not appriopriate for consideration at this time. The reasons for this include:

- Considerations involving rate structures are the domain of State public utility commissions. This includes the authority over how utilities may finance decommissioning costs. The NRC should not attempt to invade this authority.

- The costs of additional assurance must be carefully weighed against improved public health and safety. For the most extreme case, probably prepayment, NUREG-0584, Revision 2, "Assuring the Availability of Funds for Decommissioning Nuclear Facilities," estimate a present value cost of about $283M (1979 dollars), using certain assumptions. This $283M present value cost of the prepayment option contrasts to an actual decommissioning cost of less than $50M (today's dollars); the difference between the two represents the cost of the additional assurance. Less extreme financial assurance methods will accordingly have lower associated costs.

- In assessing costs, it should be understood that the additional cost of assurance does not represent an additional product, i.e., it would represent a decline in the industry's overall productivity without significant health and safety benefits and therefore an increase in inflation (rate-payers would presumably have to pay more for the same amount of electricity without adequate accompanying benefits.

Perhaps the point made in the preceeding item is the most important. The actual cost of the decommissioning effort will be unchanged, regardless of the degree of assurance or who pays for it. At this time, with inflation running at record levels and a new administration's commitment to reduce it, additional regulations of the type contemplated do not provide enough benefit to the public's health and safety to be warranted.

ATTACHMENT II

CONCLUSIONS OF NUREG-0586 THAT PSI AGREES WITH

1) "In any given year the quantity of (radioactive waste) generated by decommissioning will be considerably less than that generated by operating nuclear facilities." p. 0-8

2) "A reactor can be decontaminated with reasonable occupational radiation exposure and with virtually no public radiation exposure." p. 0-9

3) While the Elk River reactor "was quite small compared to present-day power reactors, its decommissioning served to demonstrate a reactor can be decontaminated safely with little occupational or public risk." p. 0-13

4) "Decommissioning of nuclear facilities is not an imminent health and safety problem." pp. 0-39 and 15-2

5) "The major adverse environmental impact of decommissioning is the commitment of small amounts of land for waste burial in exchange for reuse of the facility for other nuclear or non-nuclear purposes." p. 0-39

6) "The primary objective of the NRC with respect to decommissioning is to protect public health and safety." p. 0-40

ATTACHMENT III

PSI SPECIFIC COMMENTS ON NUREG-0586

To avoid redundancy, this attachment does not discuss any comments that do not offer additional information over Attachment I.

1) p. iv, "SCOPE OF THE EIS"

The draft GEIS "does not address the considerations involved in extending the life of a nuclear facility," and indicates this "is outside of the scope of this EIS." However, the NUREG additionally states on p. 0-4 (and again on p. 2-5) that "Conversion to a new or modified use is also considered," and "if the intended new use involved radioactive material and, thus was under NRC licensing authority, an application for the new use would be reviewed as amendments to the existing license under appropriate existing regulations. If the intended new use does not involve radioactive material, i.e., unrestricted public access, and does not come under NRC licensing authority, then such application for a new use would be reviewed as a request for decommissioning and termination of license."

In the realistic case it is expected that extension of the facility use, either for nuclear or non-nuclear means, will occur for many cases. This is particularly true when considering that:

- o Ultimate decommissioning cannot occur until commercial high level waste repositories exist.
- o Over 50% of this country's nuclear generation station sites are 2, 3, or 4 unit sites. (It is generally agreed that the presence of other operating reactors at a site is one factor favoring the SAFSTOR option.)

PSI also notes that another version of SAFSTOR exists, where a non-nuclear use of the facility might be desirable. Presumably the high-level wastes would be removed (though not necessarily offsite) and decontamination would have taken place. An obvious example might be the use of the containment building as a "cold" high bay, or as a maintenance shop area. Stabilization of potential contamination may be needed, along with dosimetry, air sampling equipment, etc., along with an appropriate NRC license since radiation levels may not be low enough for unrestricted use. Of course, this would not be a "public access" facility.

DOE has several examples of this option at various research and development laboratories. PSI believes that the final GEIS should be edited to reflect this as a SAFSTOR option. If regulations are promulgated dealing with decommissioning options this case should be included as it is quite likely.

2) p. v, "REGULATORY OBJECTIVE"

This section states, "Present regulatory requirements and guidance are not specific enough in many critical areas to ensure that potential problems are properly considered." As we indicate in our general comments we disagree. No new NRC regulations dealing with decommissioning are needed at this time.

The section also states that "it is clear that decommissioning can be accomplished safely and at modest cost shortly after cessation of facility operation and it is considered reasonable that decommissioning should be completed at this time." If decommissioning here does not refer to a particular decommissioning alternative, the statement is true. However if ultimate decommissioning (i.e., removal of virtually all radioactive material from the site is implied, then other factors as referenced elsewhere in the NUREG may suggest the SAFSTOR or ENTOMB alternative). Again the high-level waste repository situation may completely remove some options.

The section states, "Delay in the completion of decommissioning would be primarily for reasons of health and safety considerations, since it is recognized that with delay there may be reduction in occupational dose and radioactive waste volume for some facility types due to radioactive decay." Again, if ultimate decommissioning is implied here, PSI points out that the differences in public health and safety impacts from one decommissioning alternative to another, as presented in the NUREG, are not that great. At some point costs of decommissioning (including alternate uses of the facility if it is not fully decommissioned) should be considered. Again, the Federal government apparently subscribes to this practice, as DOE facilities have been converted to other uses without full decommissioning.

3) p. vii, "PRELIMINARY CONCLUSIONS ON DECOMMISSIONING IMPACTS"

This section states that, "making the facility available for unrestricted use......also releases valuable industrial land that can be reused with great benefit." This is an assumption that may not be correct, depending upon regional considerations. PSI additionally notes that utilities should continue to be able to "reuse" the land without necessarily making it "available for unrestricted use." Also there is no requirement that the land be turned over to the public, at any time after cessation of reactor operation.

4) <u>p. vii, "INCORPORATION OF EIS CONCLUSIONS IN REGULATIONS"</u>

The NUREG states, "It is recommended that specific implementation of regulatory activities be performed by rulemaking to existing regulations (i.e., 10 CFR Parts 30, 40, 50, 51, 70 and 72) rather than a separate regulation solely covering decommissioning." If decommissioning regulatory activities do occur, PSI believes a separate regulation would be more effective and better understood.

5) <u>p. 0-2, Section 0.1.1.1, "NEPA REQUIREMENTS"</u>

This section states, "The National Environmental Policy Act (42 U.S.C. 4321 et seq.) requires that all agencies of the Federal Government include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on various particulars describing analysis of environmental impacts for the proposed activity." This has not been adequately done. The discussion of the environmental impacts of the recommended regulations should include discussion of the impacts which would occur if the new regulations are not provided.

6) <u>p. 0-7, Section 0.2.5.3, "IMPLEMENTATION OF OBJECTIVES"</u>

The NUREG states that, "decontamination costs of a facility are essentially independent of the level to which it must be decontaminated as long as that level is in the range of 1 to 25 mrem/year to an exposed individual." Although this may generally be true if "decommissioning" is intended here, rather than "decontamination"* it is not necessarily the case. However if "decontamination" is actually intended here, PSI disagrees. The historical experience is that as one decontaminates to lower and lower levels, the costs per increment go higher and higher.

7) <u>p. 0-10, Section 0.4.3.1, "DECON"</u>

This section compares the cost and schedule of the DECON option for a PWR to the cost and schedule for building same. The comparison is inappropriate. A valid comparison is the costs/schedules/public and worker health and safety for DECON versus SAFSTOR versus ENTOMB.

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* In decommissioning, the larger portion of the costs will probably relate to the removal and disposal of highly radioactive equipment, therefore the activities intended to further reduce radiation levels may seem small compared to the overall cost.

8) p. 2-8, Section 2.4.3, "SAFSTOR"

The second paragraph on this page states, with regard to SAFSTOR: "It is not intended that the facilities will ever be reactivated." As was discussed in comment 2) of this attachment, an additional SAFSTOR option where the facilities may be given a somewhat different use (though some equipment might retain the same functions) should be included.

9) p. 2-12, Section 2.5.3, "IMPLEMENTATION OF OBJECTIVES"

The NUREG states that, "for the PWR case.....a residual radioactivity level corresponding to 5 mrem/year or less would be justifiable on the basis of survey costs." This is based on the estimated costs of $250,000 and $225,000, respectively, for 5 mrem/year and 25 mrem/year survey efforts. The decontamination cost differences in going from 25 to 5 mrem/year dose rates should also be considered in establishing acceptable residual radioactivity levels. This, in part, is why PSI supports the ALARA concept in determining unrestricted release levels.

ARKANSAS POWER & LIGHT COMPANY
POST OFFICE BOX 551 LITTLE ROCK, ARKANSAS 72203 (501) 371-4000

April 30, 1981

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,72 (35)
(46 FR 11666)

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Office of the Sec.
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GR-0481-20

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Washington, D.C. 20555

SUBJECT: Decommission of Nuclear Facilities
NUREG-0586
(File: 1510.3, 2-1510.3)

Gentlemen:

Based on our review of the Draft Generic Environmental Statement on Decommissioning of Nuclear Facilities, attached are our comments to aid in establishing criteria and new standards for decommissioning.

Very truly yours,

David C. Trimble

David C. Trimble
Manager, Licensing

DCT:GAC:lp
LBY
Attachments

COMMENTS ON NUREG 0586

Page	
iii	The statement that "more specific and detailed regulatory guidance" is needed is more of an assumption than a supported conclusion and thus colors the entire report.
iv	The description of decommissioning as an activity that results in "unrestricted use of the facility and site" is inaccurate since some forms of decommissioning do not.
v	There are few similarities between financial assurance issues for accident and routine decommissioning. Since it appears that an undecommissioned retired plant poses fewer problems of the type described than an operating one the urgency for decommissioning concluded here appears to be totally unfounded. While an owners economic decision may dictate prompt decommissioning, impacts of delayed decommissioning on areas within the governments responsibility appear to be insignificant.
v & vi	Seeking a "high degree of assurance" is inconsistent with the Atomic Energy Act as interpreted by the Courts and by the Commission themselves. The adopted standard is one of "reasonable assurance". Since the annual costs of routine

decommissioning of the immediate dismantlement type are on the same order of magnitude as other contingency costs currently incurred by owners of nuclear power plants, e.g. storm damage, and since there are really no good reasons not to slow the decommissioning down to further lower the annual cost if necessary, internal reserves do provide reasonable assurance. Because it does, NRC has no authority to encroach upon state and FERC jurisdiction over economic matters by eliminating internal reserve funding.

vi Any plans required for submittal as part of an application to operate or construct a facility should be limited in scope to that required to show that the applicant possesses or has reasonable assurance of obtaining the funds necessary to pay the costs of permanently shutting the facility down and maintaining it in a safe position. This completely satisfies the NRC's responsibilities under the Atomic Energy Act until such time as the decommissioning begins. At that time, compliance with the requirements for receipt of a Type A specific license of broad scope for byproduct material is sufficient to satisfy the NRC's responsibilities under the Atomic Energy Act. Accordingly, currently promulgated regulations under 10CFR 50.33(f), 10CFR 50.82, and 10CFR 33 are quite adequate. In addition, since the health and safety of the public necessarily includes economic impact on the public, the de-emphasis of economics is inconsis-

Page

tent with the NRC's responsibilities under the Atomic Energy Act.

vi The residual radioactivity discussions fail to address release criteria for recycled materials. Work done in this area on a cost-benefit basis indicates the acceptability of release levels considerably higher than the 10 mrem/yr limit given here.

vii To the extent that the above comments take exceptions to the recommendations in the overview, exception is taken to the conclusion that those recommendations should be incorporated into existing regulations. It is submitted that no modification of existing regulations is necessary for the NRC to adequately fulfill their responsibilities in this area under tne Atomic Energy Act and that, therefore, such modifications would constitute over-regulation.

0-1 There are few similarities between financial assurance issues for accident and routine decommissioning.

0-2 The purpose of decommissioning should be changed to eliminate references to unrestricted use and instead concentrate on reasonable assurance of the public health and safety which can be accomplished without being able to release the facility for unrestricted use. The stated purpose is an erroneous and unsubstantiated conclusion regarding decommissioning alternatives that colors the entire report.

Page

0-4 Regarding section 0.2.3 see previous comment on page 0-2. The first sentence of section 0.2.4 is much more appropriate.

The stated intent to end nomenclature confusion is admirable but unsuccessful. The nomenclature of Regulatory Guide 1.86 has been used with good consistency and little confusion for several years and introduction of new nomenclature into a technology with relatively stable nomenclature would seem counter-productive to the stated intent. The exclusion of conversion from the discussion seems to preclude conversion to a low level disposal site which would eliminate transportation hazards and could result in equally as adequate disposal as offsite disposal. This appears to be a glaring deficiency.

0-6 Regarding section 0.2.5 see previous comment on page 0-2. The statement that existing regulations are not specific enough is unsubstantiated. Even section 2.5.1 claims no deficiencies of specificity.

0-7 This discussion and that in section 2.5 seem to confirm the adequacy of existing regulatory guidance in the area of residual radioactivity levels.

0-8 See previous comments on pages v & vi. In addition, there has been no showing that a delay in performing a routine decommissioning could result in a health and safety problem (in fact it probably could not). The necessity of assurance of timely availability of funds is therefore unsubstantiated. The inappropriate objective of release for unrestricted access has previously been commented on.

Since State utility commissions and FERC have statutory mandates to see that the regulated utility remains economically healthy, the only addition needed to current regulations, if any, is the need for a certification by the State Regulatory Commission (and/or FERC) that the applicant for a license is a regulated utility pursuant to State (and/or Federal) law. Per previous comments the existing regulations provide adequate reasonable assurance that funds will actually be available when needed. Since delays in routine decommissioning have not been shown to be harmful the necessity for enforcement procedures or direct addressing of premature plant retirement are unnecessary.

Although decommissioning costs may be minor on a percentage basis, the numbers are large on an absolute basis (and subject to continuing inflation) and the difference in the cost of various funding methods can be substantial. The statement that the impact of a mandated funding mechanism will be minor is either naive or purposely misleading. In any event, these costs are very large when compared to any health and safety benefits of one funding mechanism over another except, perhaps, for the case of a plant owner and operator who is not a regulated utility.

Page

The comparison of decommissioning waste to operating wastes generated in the industry in a given year makes an inappropriate assumption of only one plant decommissioning at a time. Several plants decommissioning simultaneously nationwide (a very real possibility) could cause decommissioning waste volumes to approach, or even exceed operating wastes volumes in a given year.

0-9 The tertiary loop may not go to cooling towers. It may be a once-through system.

0-10 The PNL numbers cited here don't agree with the PNL report NUREG/CR-0130. A non-exhaustive list of examples is provided below.

	NUREG-0586	NUREG/CR-0130
DECON cost	$ 33.3 million	$ 33.7 million
DECON occupational dose	1083 man-rem	1223 man-rem
SAFSTOR cost (30 yr. delay)	42.8 million	41.4 million
SAFSTOR cost (100 yr. delay)	41.8 million	40.6 million
SAFSTOR occupational delay (30 yr. delay)	317 man-rem	450 man-rem
ENTOMB dose transportation worker	*20/25 man-rem	16/21

Such discrepancies (and there are more) raise doubts about the veracity of NUREG-0586.

*Table 4.3.2 says this is adjusted for radioactive delay. Table 4.3.2 reference (e) says it is not.

Page

0-11 A major potential advantage of ETOMB is ignored. If the wastes from decommissioning have to be disposed of anyway, disposal in containment may be even more protective of the public health and safety than disposal in a conventional low-level waste burial ground and also eliminates transportation doses and hazards. Permanent entombment could be found preferrable to permanent burial following transport. This appears to not have been addressed.

0-12 The discussion in 0.4.5 neglects the issue in the comment on page 0-11 and concentrates primarily on the unsubstantiated significance of delays in release for unrestricted use. There really is no apparent reason to select a single acceptable or even preferrable alternative among those presented. Different alternatives may be preferrable at different times and places or under different circumstances.

0-33 Page 0-10 says 1083 man-rem. This page says 1183 man-rem and NUREG/CR-0130 says 1404 and 1223 man-rem. All of these numbers are supposedly based on the same assumption and from the same source. Such discrepancies do not lend to placing ones confidence in NUREG-0586.

0-34 The health and safety advantage of maintaining a shallow land burial for several hundred years over maintaining entombed facilities for several hundred years is not apparent. If the conclusions drawn here are based on the assumption of such an advantage, the conclusions are unsubstantiated.

Page

0-35 The 40 year reactor operating lifetime is normally based on license lifetime and should, therefore, be counted from construction permit date, not beginning of operation. The first reactor would, therefore, complete DECON by the end of the 44th year and so on.

0-38 See comments on pages v and 0-6.

0-39 Conclusion 2 regarding the health and safety significance of pre-commissioning planning for decommissioning is unsubstantiated.

See comment on pages 0-2, 0-11 and 0-12.

0-40 Regarding 0.15.1.1.2 see comments on page 0-12.

Regarding 0.15.1.2 see comments on page vi.

0-40 & 0-41 Regarding 0.15.1.3 see comments on pages v, v & vi, 0-2 and 0-8.

0-42 See comments on page vi.

0-44 & 0-45 See comments on page 0-10. Why are these numbers different from those in the PNL reports?

GENERAL

I. Several unsubstantiated biases obviously underlie and form a foundation from which NUREG-0586 is built. As a result the report is colored to favor conclusions drawn from these biases. The major biases are summarized below.

1. Assumption that delayed decommissioning presents potential health and safety problems. This is mentioned several times but no such potential problems are described.

2. Assumption that existing regulations are inadequate. Lack of specificity is cited but no examples of such lack of specificity are described nor are the advantages of increased specificity enumerated or described. They are assumed to be there. Could the assumption be based on the philosophy that more regulation is better?

3. Assumption that the costs of routine decommissioning in a given time period are extraordinary in their level of financial impact. Not only is the financial health of a utility protected by statutorial mandate but costs of similar magnitude are incurred frequently, often without warning by utilities. To say that such costs are trivial would be irresponsible but to say that they could cause a utility to go under would be naive, especially considering the fact that they are known about in advance and can be delayed with no detriment except to cost.

4. Assumption that entombment is unacceptable. This was a conclusion reached in the first PNL report on PWR's. One of the reasons that the addendum to that report was required was because such a conclusion was inadequate. The reason for disposing of wastes, that must be disposed of somewhere, at another location besides the reactor site is not obvious and any institutional issues regarding long term continued surveillance and maintenance applies to any location chosen for disposal. No health and safety benefits of packaging wastes, transporting them to another location and disposing of them instead of disposing of them in place has been demonstrated. In NUREG-0586, every opportunity to note entombment's unacceptability and ignore its potential seems to be taken. A good example is the first paragraph of section 4.4. It appears from the tone of the report that an attempt to defend the original position on entombment taken in NUREG/CR-0130 is being made.

5. Assumption that it is desirable to select a preferred decommissioning method.

6. Assumption that there is something useful that NRC can do with decommissioning plans submitted 40 years (or more) before decommissioning takes place. This is especially ludicrous for plants already licensed since the excuse that decommissioning may be optimized by proper plant design doesn't even exist for those plants. Speculation on technology and methods that will exist in 40 years is inappropriate use of resources.

7. Assumption that decommissioning following a major accident should be provided for in the same manner as routine decommissioning. The costs are totally different, the urgency can be quite different (if clean up operations are included as part of decommissioning) and as a result financial considerations are quite different. They are also quite unpredictable and practically handled only on an Ad Hoc basis.

8. Assumption that timely decommissioning requires a higher degree of assurance than reactor safety. The Atomic Energy Act says reasonable assurance. NUREG-0586 says high degree of assurance for timely decommissioning.

9. Assumption that a reasonable assurance of public health and safety is the same as release for unrestricted use.

These assumptions are those on which the report appears to be built and they pervade it. None of them are substantiated in the report. For most of them, there is not even an attempt made at substantiation.

II. The absence of material dealing with HTGR's is conspicuous. Nuclear energy centers have not even been built but they are addressed. There happens to be an HTGR in commerical operation in this country now.

DOCKET NUMBER
PROPOSED RULE PR-30, 40, 50, 70, 72
(46 FR 11666)

36

OFFICE OF THE GOVERNOR

WILLIAM P. CLEMENTS, JR.
GOVERNOR

Docketed
USNRC
JUL 10 1981
Office of the Sec.
Docketing & Ser
Branch
mdv

April 21, 1981

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Washington, D. C. 20555

Dear Sirs:

The Draft Generic Environmental Impact Statement pertaining to decommissioning of nuclear facilities, prepared by the U. S. Nuclear Regulatory Commission has been reviewed by the Budget and Planning Office and interested state agencies. Copies of the review comments are enclosed for your information and use. The State Environmental Impact Statement Identifier Number assigned to the project is 1-02-50-023.

The Budget and Planning Office appreciates the opportunity to review this project. If we can be of any further assistance during the environmental review process, please do not hesitate to call.

Sincerely,

F. R. Spies, Manager
General Government Section
Budget and Planning Office

epg

Enclosures: Comments by Texas Parks and Wildlife Department
Railroad Commission of Texas
Coastal and Marine Council
Texas Department of Water Resources

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Budget/Planning

April 7, 1981

Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
P. O. Box 13561, Capitol Station
Austin, Texas 78711

Re: Draft Generic Environmental Impact Statement:
Decommissioning of Nuclear Facilities
(EIS No. 1-02-50-023)

Dear Mr. Wrotenbery:

This agency has reviewed the above-referenced document and has no comments to offer.

I appreciate the opportunity to review this document.

Sincerely,

Charles D. Travis
Executive Director

CDT:RWS:gv

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APR 8 1981

Budget/Planning

OFFICE OF THE GOVERNOR

WILLIAM P. CLEMENTS, JR.
GOVERNOR

March 16, 1981
TRANSMITTAL MEMORANDUM

TO: Review Participants

DATE COMMENTS DUE TO BUDGET AND PLANNING OFFICE: 4/20/81

_ Aeronautics Commission
X Air Control Board
_ Animal Health Commission
_ Bureau of Economic Geology
X Coastal and Marine Council
_ Department of Agriculture
X Department of Health
_ Department of Highways and Public Transportation
X Department of Water Resources
_ Texas Forest Service
X General Land Office
_ Historical Commission
_ Industrial Commission
X Parks and Wildlife Department
_ Public Utilities Commission
X Railroad Commission
_ Soil and Water Conservation Board
_ Texas Energy and Natural Resources Advisory Council
_ Governor's Office of Regional Development

[X] Draft EIS [ ] Other EIS Number 1-02-50-023

Project Title Draft Generic Environmental Impact Statement: Decommissioning of Nuclear Facilities

Originating Agency U.S. Nuclear Regulatory Commission

Pursuant to the National Environmental Policy Act of 1969, Office of Management and Budget Circular A-95, and the Texas Policy for the Environment (1975), the Governor's Budget and Planning Office is responsible for securing the comments and views of local and State agencies during the environmental impact statement review process.

Enclosed for your review and comment is a copy of the above cited document. This Office solicits your comments and asks that they be returned on or before the above due date. You may find the questions, listed on the reverse side, useful in formulating your comments.

For questions on this project, contact Ward Goessling at (512) 475-6021.

Please address your agency's formal comments to: Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
P.O. Box 12428
Austin, Texas 78711

Suggested Questions to be Considered by Reviewing Agencies:

1. Does the proposed project impact upon and is it consistent with the plans, programs and statutory responsibilities of your agency?

2. What additional specific effects should be assessed?

3. What additional alternatives should be considered?

4. What better or more appropriate measures and standards should be used to evaluate environmental effects?

5. What additional control measures should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources?

6. How serious would the environmental damage from this project be, using the best alternative and control measures?

7. What specific issues require further discussion or resolution?

8. Does your agency concur with the implementation of this project?

As a part of the environmental impact statement review process, the Budget and Planning Office forwards to the originating agency all substantive comments which are formally submitted. If, after analyzing this document, you conclude that substantive comments are unnecessary, you may wish to so indicate by checking the box below and forwarding the form to this office. This type of response will indicate receipt of this document by your agency and that no formal response will be prepared.

[X] No Comment.

Murray C. Moffatt

Name and Title of Reviewing Official
Murray C. Moffatt
Engineer

April 3, 1981

Railroad Commission of Texas (Oil and Gas Division)
Agency

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MAR 25 1981

Budget/Planning

OFFICE OF THE GOVERNOR

WILLIAM P. CLEMENTS, JR.
GOVERNOR

March 16, 1981
TRANSMITTAL MEMORANDUM

TO: Review Participants

DATE COMMENTS DUE TO BUDGET AND PLANNING OFFICE: 4/20/81

_ Aeronautics Commission
X Air Control Board
_ Animal Health Commission
_ Bureau of Economic Geology
X Coastal and Marine Council
_ Department of Agriculture
X Department of Health
_ Department of Highways and Public Transportation
X Department of Water Resources
_ Texas Forest Service
X General Land Office
_ Historical Commission
_ Industrial Commission
X Parks and Wildlife Department
_ Public Utilities Commission
X Railroad Commission
_ Soil and Water Conservation Board
_ Texas Energy and Natural Resources Advisory Council
_ Governor's Office of Regional Development
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[X] Draft EIS [ ] Other ______ EIS Number 1-02-50-023

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Governor's Budget and Planning Office
Attention: General Government Section
P.O. Box 12428
Austin, Texas 78711

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[XX] No Comment.

Charles Branton, Executive Director
Name and Title of Reviewing Official

Texas Coastal and Marine Council
Agency

TEXAS DEPARTMENT OF WATER RESOURCES
1700 N Congress Avenue
Austin Texas

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April 2, 1981

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APR 14 1981

Budget/Planning

Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
P.O. Box 13561, Capitol Station
Austin, Texas 78711

Dear Mr. Wrotenbery:

Re: U. S. Nuclear Regulatory Commission, Office of Standards Development (USNRC-OSD)--Draft Generic Environmental Impact Statement (EIS) on Decommissioning of Nuclear Facilities (NUREG-0586). January 1981. (State of Texas File Reference: EIS-1-02-50-023.)

In response to your March 16 memorandum, the Texas Department of Water Resources (TDWR) staff has reviewed the referenced draft report, prepared by USNRC-OSD, pursuant to their statutory responsibility to develop new policies and regulations relative to the delicensing and decommissioning of commercial nuclear facilities at the end of their planned useful life. The categories of nuclear facilities considered in this report are: (1) pressurized water reactors; (2) boiling water reactors; (3) fuel reprocessing plants; (4) small mixed-oxide fuel fabrication plants; (5) uranium hexafluoride conversion plants; (6) uranium fuel fabrication plants; (7) multiple-reactor power stations; and (8) non-fuel-cycle materials facilities (e.g., radiopharmaceutical or industrial radioisotope supplies facilities; various radioisotope research laboratories; and, rare-metal-ore processing plants where uranium and thorium are concentrated in the tailings). Excluded from detailed generic decommissioning consideration in this report, and to be covered by separate USNRC-OSD rulemaking actions are: (1) uranium mill and mill tailings; (2) shallow land low-level waste burial; and (3) deep geologic high-level waste burial.

From the standpoint of our statutory responsibilities and interests, relative to statewide water resources planning, development, and management, pursuant to the Texas Water Code, we offer the following staff review comments:

1. We concur in principle with USNRC-OSD's basic policy that the basic purpose to be achieved in decommissioning the said categories of nuclear facilities (at the end of their planned useful lives or when circumstances require the premature closure of the facilities and termination of their operating licenses) is to withdraw the facilities safely from radioactive service, and to remove or isolate the associated sources of radioactivity effectively from the human

P.O. Box 13087 Capitol Station • Austin, Texas 78711 • Area Code 512/475-3187

environment so that facilities and properties can be released for unrestricted use. (Sections 0.1.4, 0.2.3, and 0.2.5.) However, we suggest that mention be made in the report that a facility and property released for unrestricted use, includes all cooling water impoundments and related facilities, including dams, levees, channels, and related installations, provided that these physical water-related elements are positively cleared as being within the authorized Federal and State residual radioactivity levels. In addition, such facility termination will also involve the relinquishment of permitted appropriated water rights, and wastewater discharge orders and permits, as stipulated therein.

2. We note the basic thrust and finding of the referenced report indicating that the decontamination (DECON) alternative of decommissioning is preferred to either the in-place safe-storage (SAFSTOR) or the in-place entombment (ENTOMB) alternatives. While we concur generally with this basic thrust resulting from the formulation and analysis of the decommissioning alternatives, we do have some reservations and concerns regarding what we perceive as three basic stated or implied assumptions adopted in the report on which the feasibility and preferability of the DECON alternative appear to depend. These assumptions are: (a) The removal of radioactive material from the terminated nuclear facility to the host site will not result in converting or transforming the host site to a facility that would endanger the regional biosphere and resources. (b) The deep geologic disposal of high-level radioactive components and wastes is technically, economically, and socially feasible and acceptable. (Section 0.4.3.1, page 0-10.) (c) The technology for the safe and economical decommissioning of nuclear facilities has already been developed. (Section 15.0, pages 15-1 and 15-2.)

   The first assumption appears to be a reasonable goal. However, we find a troublesome incompleteness in the report regarding the second and third assumptions. In addition, we have difficulty reconciling these assumptions with our findings in the review of related reports relative to the possible use of salt domes in Texas for high-level storage. Specifically, we first note the following statement in section 2.7, page 2-19, indicating that:

   > "There are no deep geologic disposal facilities for spent fuel, high-level wastes, or highly activated components. Commercial spent fuel is accumulating in reactor spent fuel ~~storage~~ pools.... Pending implementation of the IRG (Interagency Review Group) report recommendations, and construction of permanent high-level waste and TRU (transuranic) waste disposal facilities, interim storage may have to be constructed. Independent spent fuel storage installations would be one way of storing spent fuel from reactors on an interim basis. These facilities consist primarily of large water-filled pools similar to reactor spent fuel storage pools.... Interim storage of low-level waste may also be required in case of large volumes of material... or in case permanent facilities are unavail-

able..." (Underlining added for emphasis; see also, section 0.2.7, page 0-8.)

The referenced report does not explain how, where, or by whom even the interim storage for the high-level or the low-level wastes will be provided. Based on our review of relevant reports over the past few years, we find that the actual technology for the safe disposal of high-level radioactive wastes has not yet been demonstrated, and a satisfactory site has not yet been determined. The reports indicate that the United States program for high-level waste management has significant gaps and inconsistencies. The areas of greatest concern include: the adequacy of the scientific data base for geologic disposal; programs for the disposal of spent fuel rods; interagency coordination; the uncertainties in USNRC-OSD regulatory requirements for disposal of both commercial and military high-level wastes. In addition, no governmental or commercial entity has been able to determine with any degree of certainty the costs of disposing commercial radioactive waste. We find a substantial variation in scientific opinions regarding the availability of technology to deal with radioactive waste and decommissioning nuclear facilities. (e.g., Reference: House Report No. 95-1090--The Twenty-Third Report by the Committee on Goverment Operations-Nuclear Power Cost. USPO, Washington, April 26, 1978, pages 17, 24.)

Thus, it seems that the solution to the problem of permanent storage of radioactive wastes is also the key to the decommissioning problem, as it continues to be a major strategic objective involved in virtually all other phases of the nuclear program.

3. We feel that in the generic analyses presented in section 2.6.2 (Implementation of Financial Assurance Requirements), pages 2-15 to 2-18; section 2.7 (Management of Radioactive Wastes and Interim Storage, pages 2-18 and 2-19; and section 2.8 (Safeguards), page 2-10 greater emphasis should be given to the matter of potential unforeseen expenses leading to cost overruns at low-level burial sites due to unforeseen engineering needs and management control requirements, including: (a) water leaking into and out of burial trenches, involving the necessity of very expensive pumping, containment, and treatment of such waters; and (b) security systems necessitating the installation and maintenance of increasingly sophisticated fencing, monitoring, surveillance, inspection, and alarm systems.

4. We concur in principle with USNRC-OSD's finding on decommissioning regulations, as presented in seciton 15.2. Specifically, we agree that it would be more logical and reasonable to amend existing Federal regulations 10 CFR Parts 30, 40, 50, 51, 70, and 72, rather than formulate new separate regulations on decommissioning of facilities. Since decommissioning requirements are an integral consideration in nuclear facility licens-

and operation, we agree with USNRC-OSD's findings that it would be in the interest of simplicity, efficiency, and reduction in the regulatory burden to amend the pertinent parts of the cited existing Federal regulations. We suggest that wherever feasible, in each regulatory amendment, mention be made of the requirement to safeguard water resources.

5. Finally, we concur in principle with USNRC-OSD's proposed policy, presented in section 15.1.3. pages 15-6 to 15-8, on the need for assurances that adequate funds are available to a nuclear facility licensee to safely and effectively safeguard a facility resulting in its release for unrestricted use. It appears logical, as proposed by USNRC-OSD that a financial assurance plan should be submitted to USNRC-OSD by an applicant prior to the licensing of a new nuclear facility. We note that USNRC-OSD would undertake a continuing review of the financial plan to ensure that the "decommissioning fund available at the time of the facility shutdown will not differ significantly from the actual costs of decommissioning." (page 15-8, second paragraph.)

TDWR appreciated the opportunity of reviewing the referenced draft report. Please advise if we can be of further assistance.

Sincerely yours,

Charles E. Nemir

for Harvey Davis
Executive Director

PR 30, 40, 50, 70, 72
46 FR 11666
37

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Docketed
USNRC
JUL 10 1981
Office of the Sec.
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Branch
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Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities	NUREG-0586 (January 1981)

Comments of the California Energy Commission

General Comment:

Overall, the document is an excellent statement of the problems with the present regulation of decommissioning nuclear reactors and other nuclear fuel cycle facilities. The recommendations presented by the NRC in the DEIS should help greatly in relieving many present problems. We do, however, have several comments on specific portions of the document.

NRC Authority to Require Decommissioning:

The overview begins by stating that "[a]t the end of a commercial nuclear facility's useful life, termination of its license by the Nuclear Regulatory Commission (NRC) is a desired objective. Such termination requires that the facility be decommissioned." It is unclear from this document (and from conversations with NRC staff involved in decommissioning) what authority the NRC has to decide when a facility's useful life has ended and, thus, that decommissioning must commence. Our concern is that while the NRC appears to have authority to guide the course and extent of decommissioning once a licensee has decided to terminate the license, it is not clear what authority the NRC has to require a licensee to relinquish a license for a facility whose life has ended and on which decommissioning should commence. We are concerned that some operators of fuel cycle facilities, particularly reactors, might chose to maintain their operator license status long after a facility is no longer operating and to absorb the higher insurance and other costs rather than request a licensing downgrade to perhaps a "possession only" license and thus be required to commence decommissioning. Such a decision to maintain an operator license status long after facility shutdown would obviously thwart the NRC's decommissioning regulations.

This document should therefore discuss NRC authority to require the initiation of decommissioning and identify NRC criteria under which decommissioning will be required.

Additionally, with regard to fossil fuel plants, utilities commonly refurbish the facilities and continue to run the plants after their planned operating life has been exceeded. While no nuclear reactor has operated past its planned life, nuclear plant operators may well want to refurbish a plant and operate it past its assumed life. Therefore, this document should discuss NRC criteria for when it would allow such refurbishing and which components (i.e., reactor pressure vessel, steam generators, etc.) must be replaced and which might be decommissioned.

Premature Decommissioning:

Section 15.0, "NRC Policy Considerations," (p. 15-1) states that "[d]ecommissioning also includes the possibility of a premature closure of a facility, where it becomes necessary to decommission the facility prior to the end of its planned life." The NRC is to be commended for considering this important possibility that previous discussions of decommissioning have largely ignored. The DEIS (p. 15-1) does acknowledge that decommissioning occurring as a result of premature closure due to accidents may involve some technical, safety, and cost considerations not yet completely evaluated. However, the DEIS further comments (p. 15-1) that decommissioning alternatives and timing, planning, financial considerations, and recommended residual radioactivity level limits would be similar for accident and routine decommissioning. Such minimization of the factors associated with premature decommissioning is unwarranted.

Events such as Three Mile Island and the high level waste storage tanks at West Valley should demonstrate that the activities, methods, procedures and timing in cases of premature decommissioning can be quite different from what might be called normal decommissioning. The scope of work involved may be greatly expanded and the order in which certain activities need take place may be altered by special circumstances involving immediate hazards to public health.

The costs can be tremendously increased due not only to a much greater amount of work required in some such premature situations but also from the greater immediacy that may accompany this work. Such situations may even dictate the mode of decommissioning.

The Battelle PNL study on costs referred to in the DEIS would have predicted a decommissioning cost for TMI-2 of approximately $40 million. The TMI owners themselves made an estimate of $95 million to the Pennsylvania authorities prior to the accident. It is quite clear now that both of these estimates are inaccurate for the actual situation at TMI. Thus, while NRC has yet to complete its special studies on decommissioning after premature closure, the discussion in the present DEIS should be improved to more correctly state the potential for large differences in costs and procedures between normal and premature decommissioning. We further hope that future NRC documents covering premature decommissiong will acknowledge the greatly expanded problems likely to accompany such situations.

Safe Storage for 100 Years:

While we basically concur with the NRC position on the decommissioning requirements for reactors, we take exception with the recommendation to permit certain other fuel cycle facilities, such as reprocessing plants, to be placed in the SAFSTOR mode of temporary storage for periods up to 100 years (p. 15-4).

When considering financial assurance for reactor operators, the NRC recognized that such assurance would be hard to guarantee for times so far in the future. By the same token, placing into a SAFSTOR mode a reprocessing facility which will contain very significant amounts of very long-lived nuclides and thus may require active surveillance for 100 years, leads to unreasonably long temporary storage. This is especially true for those facilities where, even after this 100 year period, radiation levels would require further dismantlement before licensure could be terminated and where such facilities require active rather than passive surveillance and maintenance. Expecting any public or private entity to provide 100 years of such service appears to be unreasonable.

SAFSTOR periods for these facilities and others which raise similar concerns (fuel fabrication) should therefore be reduced to be similar to those proposed for reactors. Long periods of SAFSTOR should be permitted where only passive surveillance of facilities is required during SAFSTOR and no further work will be required to reduce radiation levels below the acceptable levels after the SAFSTOR period ends.

Financial Assurance:

We endorse the NRC objective to assure "at the time of termination of facility operations (including premature closure of the facility), that adequate funds are available to decommission the facility resulting in its release for unrestricted use." (p. 15-6.) We also endorse the NRC's recognition that the nuclear facility licensee bears the responsibility for completing decommissioning in a manner which protects public health and safety, and therefore must provide "a high degree of assurance" that adequate funds will be available for both routine and premature decommissioning (p. 15-7).

However, while the NRC has recognized that a sinking fund approach alone cannot assure adequate funds in the case of premature closure (p. 15-7) it should also recognize that neither can the prepayment method if the costs resulting from premature closure exceed those originally predicted for a "normal" decommissioning. Where premature closure involves an accident or higher than normal levels of facility contamination for any reason, the costs to decommission such facilities may well exceed the costs originally provided for by either a prepaid fund or a sinking fund.

The NRC should therefore require a special provision, such as insurance, to handle the extra costs of premature closure. We support the NRC's efforts to assist in making available such coverage for premature closure. Such a requirement should be a top priority since historically, accidents and resulting premature shutdowns have happened on a regular basis (e.g., Fermi, Browns Ferry, TMI).

Decommissioning Cost Estimates:

The document repeatedly suggests that licensees and regulatory bodies wishing to determine the estimated costs of decommissioning a facility can rely upon the Battelle PNL reports and their subsequent sensitivity analyses to derive a cost estimate for a particular facility under consideration. We take strong issue with this position. At least until a much better data base of decommissioning experience is compiled, parties involved in the planning for and financing of the decommissioning of a nuclear facility, particularly a reactor, should obtain a detailed, site and facility-specific estimate of costs from a qualified engineering firm. Such estimates need not be expensive, and are necessary since many site and facility-specific factors can result in the costs of decommissioning a particular facility varying greatly from such generic estimates as the Battelle studies.

For instances, Mr. Jon Stouky of the NUS Corporation prepared detailed cost estimates for the San Onofre 1 reactor in California. He concluded that factors such as the projected duration of decommissioning, local labor costs and productivity, the proportion of utility vs. non-utility labor, project extent and complexity, and the level of decontamination required can vary costs by as much as 250 percent for similar facilities. ("Factors Affecting Power Reactor Decommissioning Cost for Complete Removal," ANS meeting, San Diego, June 19, 1978).

The DEIS states that the sensitivity analysis performed by Battelle PNL as an addendum to their study of PWR costs (NUREG/CR-0130) concluded that costs are not substantially affected by variations in their assumptions (p. 4-7). However, this sensitivity analysis did not examine the previously mentioned range of variables considered by Mr. Stouky. It instead focused on reactor size and degree of contamination. If we apply the scaling factor Battelle derived for plant size to the San Onofre 1 reactor studied by NUS, we find that Battelle would predict the decommissioning cost to be $16 million, whereas NUS found it to be $63 million. Such differences require explanation.

NRC staff and contractors, in response to questions at the September 1978 state decommissioning workshops, acknowledged that labor costs are site-specific and that "[g]reat care must be used in applying them elsewhere" (page 253, NUREG/CP-0003). They also admitted that cost estimates for labor and waste disposal could vary by a factor of two. Furthermore, Mr. Richard Smith, manager of the Battelle PNL decommissioning studies, stated at the September 1979 state workshop in Seattle:

> Mr. Schwent: "Would you recommend in the case where a utility had a specific plant that they are going to consider decommissioning that they go out and obtain an engineering estimate or at least obtain an estimate from a firm utilizing your methodology for their particular plant so they can start with a number that fits their plant and situation?"

> Mr. Smitn: "Yes, I think so. I think you have to examine the plant specifics in every case. There are differences." (Page 162, NUREG/CP-0008.)

Because of the necessity of starting with the best cost estimate possible if financial assurance is to be achieved, we strongly urge the NRC to require licensees and regulators to obtain cost estimates specific to their facilities and locations prior to receipt of an operating license. The NRC should also specify the criteria for preparation of the cost estimates to ensure valid results.

Residual Radioactivity Limits:

While we concur with the need to establish definitive, workable residual radioactivity limits for use in decommissioning, we have some concern with the way in which the proposed NRC limits would function. Apparently, only selected nuclides determined to be the "principal" or "major dose contributors" will be monitored in determining whether a site or facility is below the limit and thus available for unrestricted use (p. 2-12). We are concerned that isotopes with relatively short half-lives that may pose initially higher exposure to the public may be selected as appropriate isotopes to monitor, while other nuclides with longer half-lives that may eventually and over a longer time span pose a greater hazard to health are ignored.

Radiation doses can be cumulative over time as well as over multiple members of society. The NRC proposes to establish an annual exposure limit to an individual of 5 mrem/year. This standard does incorporate some consideration as to the total number of such individuals exposed annually. We suggest that the NRC also set some limit as to total radiation exposure over time. Such a limit might be a cumulative dose of 500 mrem per individual lifetime as a result of any residual contamination at a site. Such a standard would give greater cognizance to cumulative dose over time and to the possible cumulative doses from contaminating nuclides of lower immediate hazard but longer life than the "major dose contributors" now being considered.

Respectfully Submitted,

Date:

EMILIO E. VARANINI, III
Commissioner, California
Energy Commission
Presiding Member of the
Nuclear Fuel Cycle

FP 817

RECEIVED

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New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

1981 MAY 19 PM 4:18

OFFICE OF THE SECRETARY
D.C.

Robert F. Flacke
Commissioner

DOCKET NUMBER
PROPOSED RULE PR-30,40,50,70,72 (38)
(46 FR 11666

April 17, 1981

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Branch

Mr. G. Donald Calkins
Decommissioning Program Manager
Divsion of Engineering Standards
Office of Standards Development
Washington, D.C. 20555

Dear Mr. Calkins:

RE: NUREG-0586

The State of New York has reviewed the Nuclear Regulatory Commission's (NRC) "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities""(NUREG-0586) issued in January 1981. We submit the following comments for the Nuclear Regulatory Commission's consideration.

This EIS relies very heavily on the supporting assessments which have been or are being developed for NRC by Battelle Pacific North West Laboratory (PNL), and frequently refers to PNL documents for in-depth analyses and discussions of technology, safety, and costs. As a result, the statement tends to be summary in nature, making a detailed technical review difficult. However, we accept the conclusions and materials presented in the EIS although we have not reviewed each supporting document in detail.

The function of the EIS would be more easily understood if the section describing the purpose included a brief description of current regulations on decommissioning, the reasons why the Commission is considering revising them, and the approximate timetable for such revision. While this information may be presented in detail in the references, the significance of the EIS is not clear from the document itself. It should be remembered that the President's Council on Environmental Quality regulations implementing NEPA states that an EIS must be readily understandable to the general public.

Additional specific comments are attached.

Thank you for the opportunity to comment on this document. We look forward to reviewing in the future more specific actions regarding decommissioning.

Sincerely,

Janice Corr
Assistant Commissioner for
Energy & Regulatory Affairs

Attachment

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COMMENTS OF THE STATE OF NEW YORK

on the

Draft Generic Environmental Impact Statement

on Decommissioning Nuclear Facilities

(NUREG-0586)

1. The Statement does not address decommissioning of research or test reactors. Unlike high-level waste repositories, low-level waste burial grounds, and uranium mills which were explicitly excluded, no specific reason for the exclusion of research and test reactors is given. While much of the generic discussion would seem to apply to research and test reactors, they appear to be excluded from the definitions of "fuel-cycle" and "non-fuel cycle" facilities. This matter should be clarified.

2. Section 0.2 (page 0-7)

   a. The third paragraph on page 0-7 states in part:

      "Consideration of these factors can be applied in order to convert the radiation levels as measured by the terminal radiation survey to a dose that a member of the public would realistically be expected to be exposed to from the decommissioned nuclear facility." (emphasis added)

      For technical clarity, the emphasized expressions should be replaced with "radiation and/or residual radioactivity levels"and "receive", respectively.

   b. The last paragraph on page 0-7 states:

      "However, survey costs are expected to be small in comparison to the overall decommissioning costs, and decontamination costs of a facility are essentially independent of the level to which it must be decontaminated as long as that level is in the range of 1 to 25 mrem/yr to an exposed individual.(1), (3)"

      A similar statement is made in the last paragraph of page 2-12. A review of the references cited revealed no discussion of the sensitivity of the cost of decommissioning to the dose level from residual activity.

      Intuitively, the costs of decontaminating to 1 mrem/yr would appear to exceed the costs of decontaminating to 25 mrem/yr due to the greater sensitivity required in the final survey and the additional volume of waste that would be generated. While the difference in cost may be a small increment for major facilities (e.g., power plants), it could be a substantial increase for smaller scale non-fuel cycle facilities. Similarly, the survey costs may be small in comparison to the overall decommissioning costs for major facilities, but for certain material licensees, the survey costs may be the only costs. These matters should be clarified.

3. Subsection 0.4.4 (page 0-12)

In the third paragraph on page 0-12, it is stated that certain highly activated components of a reactor and its internals will be placed in a deep geological disposal facility (i.e., high-level waste repository). It should be recognized that such material does not meet the currently accepted definition of high-level waste and that such components have, to date, been disposed of in low-level burial grounds. Such waste classification is one area where specific regulatory guidance will be required.

4. Section 0.14 (page 0-34)

The first and second paragraphs of Section 0.14 quote figures of 20,000 and 16,000 respectively, for the number of non-fuel cycle facilities. There is no apparent reason for the discrepancy.

5. Subsection 2.5.3(page 2-14)

The first paragraph on page 2-14 refers to an exposure level of "5 μr/hr". Although not explicitly stated, this level is presumed to be in addition to the natural background levels since, in most cases, 5 μr/hr is below natural background levels from cosmic and terrestrial sources. This matter should be clarified.

6. Subsection 2.6.2 (page 2-16)

In the analysis of funding alternatives in the EIS, the staff should investigate an inter-utility emergency decommissioning fund as a means of providing financial assurance. This fund could be held, invested, and managed by NRC with each utility contributing annually from $500 to $1,000 per MW of nuclear capacity. Guidelines should be written, defining what types of emergencies would qualify for use of the fund, including the requirement that the utility receiving funds must not be at fault in whatever emergency occurred. Requests for funds could be reviewed by a joint utility-NRC board.

Establishment of such an emergency financial assistance program would allow utilities to use a sinking fund to prepare for decommissioning at the projected end of the plants' useful lives, without having to be financially prepared for an emergency decommissioning.

7. Subsection 4.3.1 (page 4-3)

The third paragraph of Subsection 4.3.1 contains the expression "850,000 million". This appears to be an editorial error. The word "million" should probably be deleted.

8. Table 4.3-2 (page 4-4)

It appears that the title of Table 4.3-2 should read "Summary of Radiation Safety Analyses for Decommissioning the Reference PWR (values are in man-rem)."

9. Sections 4.5,5.5, and 7.5 (pages 4-12, 5-10, and 7-14)

   In the Comparison of Decommissioning Alternatives for the pressurized water reactor and the boiling water reactor, the statement is made that the "larger occupational radiation dose" resulting from DECON "is considered of marginal significance to health and safety." On page 7-14, a similar statement is made regarding DECON of Fuel Reprocessing Plants. The basis for this consideration should be presented in the EIS, so that it can be understood by the general public.

10. Subsection 7.3.1 (page 7-4)

    The last sentence of the second paragraph on page 7-4 refers to "Table 5.3-2." It appears that the correct reference is Table 7.3-2.

11. Subsection 14.1.2 (page 14-3)

    Subsection 14.1.2, which discusses Radiochemical and Radiopharmaceutical Manufacturers, fails to recognize the case where isotopes are produced in on-site reactors such as the Union Carbide Corporation facility in Tuxedo, New York.

12. Subsection 14.3.2.1 (page 14-9)

    In discussing the DECON option for sealed source and radiochemical manufacturers the statement is made "all the wastes have to be placed in packages surrounded by activated charcoal in a steel drum." While such a method may be appropriate for transportation of highly volatile or gaseous waste, it would not be required for all wastes. In most cases, only solid waste would be accepted at burial facilities.

13. Glossary (pages G-1 to G-2)

    It would be helpful if the chemical symbols used in the EIS were included in the glossary.

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Docketed USNRC
JUL 10 1981
Office of the Sec. Docketing & Serv. Branch

Decommissioning Program Manager
Division of Engineering Standards
Office of Standards Development
Washington, D.C. 20555

Sirs:

Ohio Citizens for Responsible Energy presents this comment on the "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586.

(1) There is an apparent contradiction between the viability of the ENTOMB alternative conclusion and that reached in the Summary of Estimated Costs(Table 0.0-2, p. 0-45). The Table yields a cost figure for PWR entombment while Section 0.2.4.4(p. 0-6) states that entombment is NOT a viable alternative where the structural integrity of a facility(PWR) cannot be ensured for the half-life of radioactive isotopes present. The table should be amended to reflect the reality of this particular alternative with PWR's.

(2) A second contradiction exists as to time required to use DECON alternative on a PWR. In Section 0.2.4.2 (p. 0-5), DECON may last "up to approximately 4 years for a large PWR." But Section 0.4.3.1(p. 0-10) gives the impression that DECON will require a minimum of 4 years after cessation of reactor operation. That discrepancy should be resolved.

(3) Granted that the bulk of Table 4.3-1 is from the 1978 NUREG/CR-0130, have the implications of the TMI incident in 1979, especially in regard to that plant's external security since the accident, been considered in this Table's Continuing Care section under SAFSTOR?

This group thanks the Manager of the Decommissioning Program for this opportunity to offer additional insight into this critical area.

Sincerely,

Jeff Alexander for: Ohio Citizens for Responsible Energy
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Dayton, OH 45420

J.A. Savage
Star Route
Blue Lake, CA 95525

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(46 FR 11666)

40

Docketed
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JUL 10 1981
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Docketing & Ser.
Branch
mdv

March 8, 1981

NRC
Washington D.C. 20555

Re Draft Decommissioning Report

Dear NRC staff:

I am pleased that the NRC has addressed the issue of decommissioning. I live near the shut-down Humboldt Bay Nuclear Power Plant. This plant appears to be the prime candidate for the country's first experiment in commercial reactor decommissioning, so I read your report with great interest.

I am pleased that you are recommending that decommissioning be built into new reactors, and advance concern be given to health and safety and economics before a utility receives a license. But this is the main weak point of the EIS. Overall, you are addressing facilities that have not been licensed and not fully looking into what to do with what we have. There are very few reactors that are still being built. And, none on order. The EIS glosses over this fact. It makes no concrete proposals about how to deal with plans for decommissioning that are made just prior to, or after facility shutdown.

First, being specific, I would like to address "returning the site to unrestricted access". This is supposedly based on "realistic" assesments, where occupancy is less than full time. Later in the EIS there is mention of building houses on former nuclear sites. This is inconsistent. People live in houses full time. There is no mention of specifics on how proper shielding could be done or if it has been done. As far as I can find out, no decommissioned reactor has yet been open to unrestricted access. The EIS only takes into consideration the human species. Since most reactors, including Humboldt, are not built in the middle of cities, you must also consider other species (cockroaches don't count). Humboldt is a salt marsh where many wild animals take refuge. What will these unshielded animals do?

It is mentioned, without explanation, that decommissioning will have a positive environmental impact. Well, I am sure you are talking about long-term environmental effects. I question that too, but short term effects are also important. Especially for the people who live near the facilities. There will be employment effects, land effects and economic effects. "A small amount of land" will be committed for waste storage , but effects that the "small amount of land" will have on surrounding communities, is not mentioned.

It is stated on page 0-42 that cost-benefit considerations are not expected to have a major impact. That is contradicted in the entire argument over planned costs and funding of decommissioning--each rem will cost x amount to clean up. And the EIS talks of a certain cut off point implicit in ALARA where it is no longer cost effective to clean it up any further. This argument bothers me the most. For one, it appears that the ratepayer or taxpayer will pay and we deserve to have a "clean" environment, not one to 10mrem more than what was there before. So I'm an idealist, but it was expected when these things were built, that the land would be returned to the way it once was, not 5 or 10mrem more radiation.

I am happy to see concern over financial assurances. The options are well laid out. But, I missed any specific method in which the NRC plans to work with state PUCs on this issue. Will regulations requiring financial assurance automatically mean each state must immediately deal with it? This needs to be spelled out.

Under policy considerations the EIS addresses the technological capability in decommissioning. There is no mention of what we all know to be the human error factor. Maybe one doesn't address it in such a report. But it does exist, has TMI #2 has shown. There should be some way of dealing with it, since it is a real factor, instead of ignoring it.

Thank you for your attention to these matters.

Ms. J.A. Savage

NRC FORM 335 (8-87) NRCM 1102, 3201 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

SEE INSTRUCTIONS ON THE REVERSE

1 REPORT NUMBER (Assigned by PPMB: DPS, add Vol No., if any)	NUREG-0586
2 TITLE AND SUBTITLE	Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities
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12 SUPPLEMENTARY NOTES	

13 ABSTRACT (200 words or less)

This final generic environmental impact statement was prepared as part of the requirement for considering changes in regulations on decommissioning of commercial nuclear facilities. Consideration is given to the decommissioning of pressurized water reactors, boiling water reactors, research and test reactors, fuel reprocessing plants (FRPs) (currently, use of FRPs in the commercial section is not being considered), small mixed oxide fuel fabrication plants, uranium hexafluoride conversion plants, uranium fuel fabrication plants, independent spent fuel storage installations, and non-fuel-cycle facilities for handling byproduct, source and special nuclear materials. Excluded here from consideration for regulation change, are decommissioning of low-level waste burial facilities, high-level waste repositories, and uranium mill and mill tailings piles, which are covered in separate rulemaking activities, and decommissioning of uranium mines which are not under NRC jurisdiction.

Recommendations are made as to regulatory decommissioning particulars including such aspects as decommissioning alternatives, appropriate preliminary planning requirements at the time of commissioning, final planning requirements prior to termination of facility operations, assurance of funding for decommissioning, and environmental review requirements.

14 DOCUMENT ANALYSIS – a KEYWORDS/DESCRIPTORS	FGEIS Decommissioning
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15 AVAILABILITY STATEMENT	Unlimited
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