

Workshop D

DECOMMISSIONING
AND REGULATORY ISSUES

G. D. Calkins

DECOMMISSIONING - AN OVERVIEW

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INTRODUCTION

The nuclear field is reaching the degree of maturity that requires increased attention to the proper retirement or decommissioning of facilities. With this maturity, more nuclear plants and equipment will be entering the terminal period of their useful lives. Since most of these have been involved in handling radioactive materials the emphasis must be upon the safety of the process of decommissioning and of any radioactive residue.

The level of interest in nuclear decommissioning has increased markedly during the past year or two. A diversity of groups have indicated their interest including: the public, industry and Federal and State agencies. Meetings, such as this one, have included or keynoted decommissioning. Both the American Nuclear Society (ANS) and the International Atomic Energy Agency (IAEA) have held technical meetings on decommissioning during the past year.

In preparation for our workshop on decommissioning today, it will be desirable to review the status of the field and that will be the purpose of my remarks. A good overview will be obtained by looking at the programs of the Nuclear Regulatory Commission (NRC) and of the Department of Energy (DOE) in this country and of the International Atomic Energy Agency (IAEA). The NRC program is restricted to those facilities licensed by NRC and the DOE emphasizes non-licensed or mainly defense facilities. A summary of status of international decommissioning is best obtained by a look at the IAEA program.

I will try to point out the major issues and problems during my presentation. It will then be my intention to frame these issues and problems into the form of questions to stimulate discussion for our workshop. I will run through all of these questions at the conclusion of my talk before they are presented individually to you for your discussion and comment.

NUCLEAR REGULATORY COMMISSION (NRC) PROGRAM

The NRC has had the most active programs on decommissioning. This is a complex, multifaceted program which is described in detail in a recently revised plan, (1) NUREG-0436, Revision 1. Part of that plan includes the development of a technical data base. At this time four reports in this data base have been completed. (2) (3) (4) (5)

It is my purpose here to review these reports through a series of slides, Numbers 1-30, without reproducing the report here. The reader is referred to the report itself for more details.

DEPARTMENT OF ENERGY (DOE) PROGRAM

Activities in the area of decommissioning have been increasing at DOE. A good review of their program is contained in a recent report, (6) DOE/EDP-0028. The program includes research and development, planning and decommissioning of formerly utilized facilities not owned by DOE and of surplus DOE owned facilities. Slides 31-36 briefly summarize the DOE programs. The reader is referred to the above report for further detail.

INTERNATIONAL PROGRAMS

As in this country interest in decommissioning has been growing internationally. Since there has been less experience the international program, that of IAEA (International Atomic Energy Agency) and NEA (Nuclear Energy Agency), is only briefly summarized here. Slide 37.

ISSUES AND QUESTIONS FOR DISCUSSION AT WORKSHOP

The issues and questions in the last eight slides are presented to stimulate discussion by the participants in the workshop.

REFERENCES

1. USNRC, "Plan for Reevaluation of NRC Policy on Decommissioning of Nuclear Facilities," NUREG-0436, Revision 1, December 1978.
2. Konzek, G. J. and C. R. Sample, "Decommissioning of Nuclear Facilities - An Annotated Bibliography," NUREG/CR-0131, October 1978.
3. Schneider, K.J. and C. E. Jenkins, "Technology, Safety and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant," NUREG-0278, Vols. 1 & 2, October 1977.
4. Smith, R. I., G. J. Konzek and W. E. Kennedy, Jr., "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station," NUREG/CR-0130, Vols. 1 & 2, June 1978.
5. Jenkins, C. E., 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 & 2, February 1979.
6. USDOE, "Environmental Development Plan (EPP) - Decontamination and Decommissioning," DOE/EDP-0028, July 1978.

PURPOSE OF NRC PLAN

1. Develop Detailed Information to Support Decommissioning
2. Develop a General Decommissioning Policy
3. Develop the Attendant Changes in Regulations
4. Establish Guidance for Facilitation of Decommissioning

- Decommissioning Workshop
 - Overview of Decommissioning—
G.D. Calkins, Decommissioning Program Manager, NRC
 - N.R.C. Program
 - D.O.E. Program
 - I.A.E.A. Program
 - Workshop — All in Attendance
 - Discussion of Major Issues & Questions

CURRENT DECOMMISSIONING REGULATIONS TITLE 10 CODE FEDERAL REGULATIONS PART 50

- **Financial Qualifications**
 - **Sec. 50.33 (f)**
Requires a Determination of Applicants Financial Qualifications to Operate and Shutdown and Maintain in a Safe Condition a Production or Utilization Facility.
(This covers reactors, isotope separation and fuel reprocessing plants)
 - **Sec. 50.71 (b)**
Requires Licensee to File Cope of Annual Financial Report to Allow Annual Reevaluation.

CURRENT REGULATIONS (Cont.)

- **Application and Approval**
 - **Sec. 50.82**
Requires Application by Licensee and Approval by Commission of Termination of License Based on Demonstrated Safe Dismantlement and Disposal.
- **Specific for Fuel Reprocessing Plant**
 - **Appendix F**
Requires that a Design Objective for Fuel Reprocessing Plants Shall be to Facilitate Decontamination and Removal of All Significant Radioactive Wastes at the Time the Facility is Decommissioned.

REGULATORY GUIDE 1.86 TERMINATION OF OPERATING LICENSES FOR NUCLEAR REACTORS

- Describes Methods and Procedures Considered Acceptable for Termination of Reactor Licenses.
- Nearly Identical Guidelines Exist in Less Formal Fashion for Other Facilities.
- Generally, These Guidelines Have Been Used in the Termination of Licenses.
- Guidelines Include:
 - Alternative Acceptable Decommissioning Modes;

Mothballing	Entombment
Dismantlement	Conversion
 - Acceptable Surface Contamination Levels

REG. GUIDE 1.86 MODES

- Mothballing – Fuel and Radioactive Fluids and Wastes Removed. Monitoring and Surveillance Required.
- Entombment – Sealing All Highly Radioactive Components in a Structure Providing Integrity Until Decay to Unrestricted Levels (Table I).
- Dismantlement – Remove All Radioactive Material to Unrestricted Levels (Table I).
- Conversion to New Nuclear or Fossil Fuel System.

REG. GUIDE 1.86
ACCEPTABLE SURFACE CONTAMINATION LEVELS

<u>NUCLIDE</u> ^a	<u>AVERAGE</u> ^{b c}	<u>MAXIMUM</u> ^{b d}	<u>REMOVABLE</u> ^{b e}
U-nat, U-235, U-238, and associated decay products	5,000 dpm a/100 cm ²	15,000 dpm a/100 cm ²	1,000 dpm a/100 cm ²
Transuranics, Ra-226, Ra-228 Th-230, Th-228, Pa-231 Ac-227, I-125, I-129	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm ²	3,000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters	5,000 dpm/100 cm ²	15,000 dpm/100 cm ²	1,000 dmp/100 cm ²

STAFF TECHNICAL POSITION
FUEL PROCESSING AND FABRICATION BRANCH
INTERIM LAND CLEANUP CRITERIA FOR
DECOMMISSIONING URANIUM MILL SITES

<u>EXPOSURE PATHWAY</u>	<u>TARGET CRITERIA</u>	<u>UPPER LIMIT CRITERIA</u>
Inhalation of Radon Daughters	0.006 W L	0.02 W L
External (whole-body)	5 μ r/hr (35 mrem/year)	20 μ r/hr (140 mrem/yr)
Inhalation of Particulates (Lung)	4 mrem/year	17 mrem/year
Food Ingestion (Bone)	45 mrem/year	180 mrem/year

AREAS LACKING REGULATORY DEFINITION

- Generic Decommissioning Criteria
 - Most Fuel Cycle Facilities Not Covered at All
 - Limited Coverage for Reactors, Fuel Reprocessing
- Requirements for Planning and Facilitation
- Acceptable Levels of Residual Radioactivity – Surface and Induced:
 - Site/Soil
 - Buildings
 - Equipment
- Requirements for Assuring the Funding of Decommissioning
- Requirement on Timing – Immediate vs. Delayed

AREAS LACKING REGULATORY DEFINITION (Cont.)

- Requirements for Disposal of Wastes:
 - Highly Activated Materials
 - Long Lived, Non Tru, Low Level Materials
 - Entombment
- Requirements for Salvage of Very Low Level Contaminated Materials

OCCASION FOR REEVALUATION

- Proliferation of Disposal Sites
- Nuclear Field is Maturing
- Increased Public Awareness
 - Congressional
 - G A O

DECOMMISSIONED POWER AND DEMONSTRATION

<u>REACTOR</u>	<u>DECOMMISSIONING MODE SELECTED</u>
Saxton	Mothballed
SEFOR	Mothballed
GE EVESR	Mothballed
Hallam	Entombment
Piqua	Entombment
Elk River	Dismantled
Bonus	Entombment
VBWR	Mothballed
Fermi I	Mothballed
Peach Bottom I	Mothballed
Pathfinder	Conversion & Mothballed

COMMERCIAL REACTORS WHICH SOON MAY BE CANDIDATES FOR DECOMMISSIONING

<u>REACTOR</u>	<u>TYPE</u>	<u>SIZE (MWe)</u>	<u>YEAR OF START UP</u>
1. Shipping Port Nuclear Power Station	PWR	90	1957
2. Dresden Nuclear Power Station, Unit I	BWR	200	1959
3. Yankee Nuclear Power Station	PWR	175	1960
4. Big Rock Point Nuclear Plant	BWR	72	1962
5. Indian Point Station, Unit I	PWR	265	1962
6. Humbolt Bay Power Plant, Unit 3	BWR	63	1963

CONGRESSIONAL HEARINGS

- The Environment and the Atmosphere Subcommittee of the House Committee on Science and Technology on June 15, 1977, Regarding Nuclear Fuel Services, Inc.
- The Environment, Energy and Natural Resources Subcommittee of the House Government Operations Committee on September 13, 1977, Regarding Decommissioning of Nuclear Facilities

GAO RECOMMENDATIONS

- **To The Congress**
Because of the Magnitude, Cost and Time Already Lost, the Congress Should Designate One Lead Federal Agency—the Nuclear Regulatory Commission—to Approve and Monitor an Overall Decommissioning Strategy.
- **To NRC**
 - Require Specific Plans for Decommissioning at the Time of Licensing, Including the Decommissioning Method to be Used and a Funding Mechanism to Assure that Facility Owners Pay the Costs of Decommissioning;
 - Determine the Acceptable Levels for Induced Radiation and Surface Contamination Consistent with Environmental Standards Being Developed by the Environmental Protection Agency; and
 - Encourage States to Follow the Lead of the Commission in Adopting Comprehensive Decommissioning Planning for Facilities Under States' Control.

PIRG PETITION

- **Initiate Rulemaking to Require Bonds to Cover Cost of Reactor Decommissioning**
- **Handled Separately from Reevaluation Plan**
- **Staff has Recommended Denial Since Such Bonds are Unavailable**

TERMINOLOGY

- **Decommission** – To Remove Safely from Service and Dispose of Radioactive Residue
- **Modes** –
 - **Dismantlement** – Remove All Radioactive Material to Permit Unrestricted Release of Property
 - **Safe Storage** – Place and Maintain Property so That Risk to Safety is Acceptable for Period of Storage. Usually Followed by Dismantlement
 - **Entombment** – Encase and Maintain Property in Strong and Structurally Long-Lived Material (e.g. Concrete) to Assure Retention Until Radioactivity Decays to an Unrestricted Level

TECHNICAL DECOMMISSIONING STUDIES

- **Reactors**
 - PWR
 - BWR
- **LWR Fuel Cycle Facilities**
 - U Mill and Tailings Pile
 - UO₂ Fuel Fabrication Plant
 - Small MOX Fuel Fabrication Plant
 - Fuel Reprocessing Plant
 - Low Level Waste Burial Ground
- **Byproduct Utilization Facilities**

TECHNICAL APPROACH FOR STUDIES

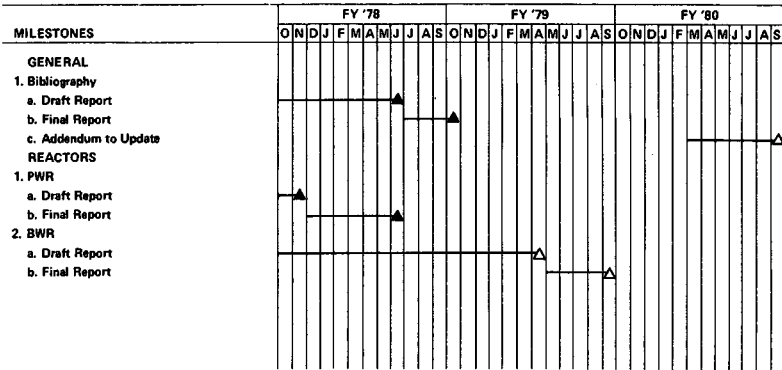
- Selection and Description of the Reference Facility and Its Site
 - Usually the Most Generic, Current Generation, Real Plant Available
 - Includes a Typical Radionuclide Inventory
- Performance of Detailed Engineering Studies on Acceptable Decommissioning Modes to Estimate for each Mode Requirements
 - Time
 - Dollars
 - Occupational Exposure
- Evaluation of the Potential Impact of Decommissioning on Public Safety for Each Mode

TECHNICAL APPROACH FOR STUDIES (Cont.)

- Evaluation of Safety and Costs of Acceptable Combinations of Modes
- Evaluation of Potential Methods of Financing the Costs
- Identification of Potential Facility and Equipment Design Changes Which Could Facilitate Decommissioning

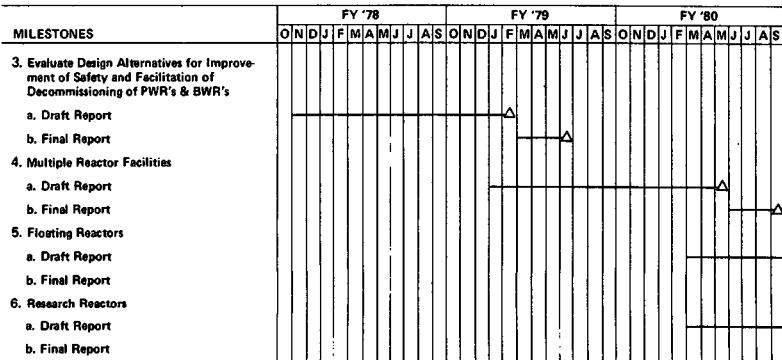
MBO-1

OBJECTIVE: Develop information base for decommissioning nuclear facilities.



△ = Scheduled
▲ = Complete

MBO-1 (Cont.)



△ = Scheduled
▲ = Complete

MBO-1 (Cont.)

MILESTONES	FY '78							FY '79							FY '80																				
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
FUEL CYCLE, BYPRODUCT & MATERIALS																																			
1. Fuel Reprocessing Plant																																			
a. Draft Report																																			
b. Final Report																																			
2. MOX Fabrication Plant																																			
a. Draft Report																																			
b. Final Report																																			
3. LLW Burial Ground																																			
a. Draft Report																																			
b. Final Report																																			

△ = Scheduled

▲ = Complete

MBO-1 (Cont.)

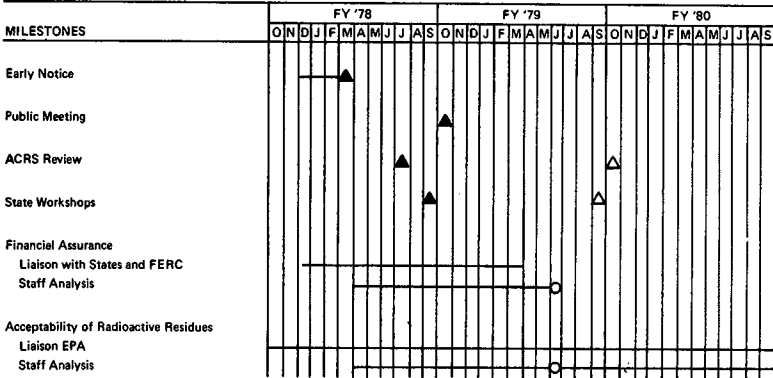
MILESTONES	FY '78							FY '79							FY '80																				
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
4. Fuel Fabrication Plant																																			
a. Draft Report																																			
b. Final Report																																			
5. Uranium Mill																																			
a. Draft Report																																			
b. Final Report																																			
6. Byproduct & Materials Utilization Facilities																																			
a. Draft Report																																			
b. Final Report																																			

△ = Scheduled

▲ = Complete

**MBO-3
SUMMARY**

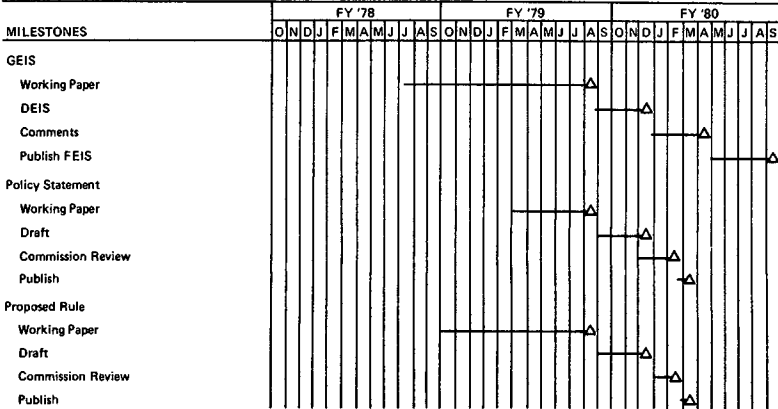
OBJECTIVE: Development of general policy and rule on decommissioning.



- △ = Scheduled
- ▲ = Complete
- = Staff Report

**MBO-3 (CONT.)
SUMMARY**

OBJECTIVE: Development of general policy and rule on decommissioning.

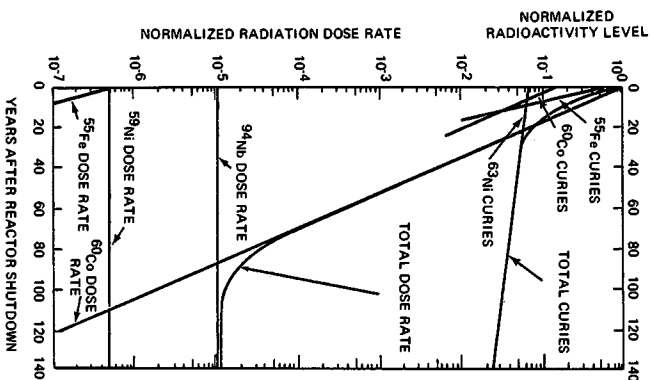


- △ = Scheduled
- ▲ = Complete
- = Staff Report

SUMMARY OF COMPLETED TECHNICAL STUDIES

	Fuel Reprocessing Plant	Pressurized Water Reactor	Small Mixed Oxide Fab. Plant
Reference Site	Barnwell	Trojan	Cimarron
Technology	Available	Available	Available
Occupational Exposure, Man Rem			
Immed. Dismantlement	530	1300	70
Safe Storage Plus Delayed (30 yr)			
Dismantlement	310	490	93
Entombment	N/A	1100	9.4
Cost, \$ Millions (1978)			
Immed. Dismantlement	66	33	7.7
Safe Storage Plus Delayed (30 yr)			
Dismantlement	77	41	28
Entombment	N/A	25 ⁽¹⁾	2.8 ⁽¹⁾

(1) Plus surveillance costs until decayed to unrestricted level.



TIME DEPENDENCE OF RADIOACTIVITY LEVELS AND RADIATION DOSE RATES IN THE ACTIVATED REACTOR COMPONENTS

POTENTIAL PROBLEM IMPURITIES

<u>IMPURITY</u>	<u>MATERIALS</u>	<u>ACTIVATION PRODUCT</u>	<u>HALF LIFE (YRS)</u>
Silver	Steels	Ag ^{108M}	130
Samarium	Steels/Concrete	Sm ¹⁵¹	93
Europium	Steels/Concrete	Eu ¹⁵² & Eu ¹⁵⁴	13.4 & 8.4
Holmium	Steels/Concrete	Ho ¹⁶⁶	1200
Uranium	Concrete	Fission Products	Mixed

MILL TAILINGS LEGISLATION H.R. 13650 (1978)

- Title 1. Remedial Action Program
 - Cleanup of Inactive Tailings Sites
 - Stabilize and Control the Tailings
 - Allows Extraction of Residual Values
 - Custody of Both the Residual Materials and Land to U.S.
 - Under NRC License

MILL TAILINGS LEGISLATION (Cont.)

- Title 2. Licensing and Regulation
 - Includes Tailings in Definition of Byproduct Material
 - License must Contain Terms and Conditions to Assure
 - Licensee Will Comply with NRC Decommissioning Standards
 - Ownership of Land and Tailings by U.S. or a State
 - Land and Byproduct Materials Maintained under NRC License

DEPARTMENT OF ENERGY (D.O.E.) PROGRAMS

- R&D Program
- Standards & Criteria Development
- Marshall Island Safety
- Grand Junction Remedial Action
- Formerly Utilized Facilities
- Inactive Mill Sites
- Surplus D.O.E. Facilities
- Decommissioning Program

D.O.E. R&D PROGRAM

- Reduction & Metals Recovery (Al & Ca)
- Surface Decontamination of Concrete
- Radioactive Waste Storage Tanks
- Removal of Actinides from Soil
- Decommissioning Handbook
- Facilitation of Reactor Decommissioning

D.O.E. STANDARDS & CRITERIA DEVELOPMENT

- Allowable Limits of Uranium in Soil
- Criteria for Real Property Contaminated with Radium
- Develop Criteria for Property
 - For Unconditional Release
 - For Conditional Release

22 INACTIVE MILL SITES

- Needed Legislation Passed 1978
- Requires Cleanup & Stabilization of Tailings
- Custody of Both Residual Materials & Land to U.S.
- Remains Under NRC License

SURPLUS D.O.E. FACILITIES

- Surveillance/Documentation
- Planning/Engineering/Cost Estimating
- Decommissioning/Remedial Action

D.O.E. DECOMMISSIONING PROGRAM

- Facilities at Santa Susana
 - Sodium Reactor Experiment
 - SNAP Facilities
 - Decontamination Facilities
- Facilities at Hanford
 - Priorities from Computer Program
 - Plutonium Concentration Building
 - 105F Production Reactor
- Miscellaneous at Various Sites
 - Test & Demonstration Reactors
 - Fission Product Development Lab.—ORNL
 - Nuclear Rocket Site at Nevada

INTERNATIONAL OVERVIEW (IAEA, NEA)

- Foreign Experience is Less But Coming to Same Conclusion
- As in U.S. Major Problem is Definition of de minimis Level
- Have Done Some Work on a Code for Decommissioning But Will Not be Published Soon
- Have Defined 3 Stages of Decommissioning Similar to Ours
- Seems to be Little Interest in Permanent Entombment
- Are Trying to Organize a Joint Reactor Decommissioning Project

ISSUES FOR WORKSHOP DISCUSSIONS

1. The recent legislation on mill tailings requires cleanup and stabilization of the tailings and transfer of the associated land and tailings to the Government with continued licensing by NRC. Should this solution be applied to allow entombment of reactors and fuel cycle facilities with transfer of the land and radioactive materials to the Government?

ISSUES FOR WORKSHOP DISCUSSIONS (cont.)

2. When a de minimis level has been defined for the unrestricted release of property should the ALARA principle be applied to it?

3. Should a lower allowable public dose from a decommissioned, rather than an operating facility be required since the property is no longer productive?

ISSUES FOR WORKSHOP DISCUSSIONS (Cont.)

4. Should a lower maximum allowable occupational dose be enforced during the decommissioning operations because the facility is no longer productive?

5. Should less stringent criteria concerning assuring the availability of decommissioning funds be applied to controlled facilities such as nuclear power stations under public utility commissions?

ISSUES FOR WORKSHOP DISCUSSIONS (Cont.)

6. Should the threshold of detectability of radionuclides be a major factor in developing a de minimis level? If so, how?

7. Should natural radiation background be a major factor in developing a de minimis level? If so, how?

ISSUES FOR WORKSHOP DISCUSSIONS (Cont.)

8. Most of the participants at NRC's State Workshops on Decommissioning believed that a dose of 1 mrem per year to the maximum individual was far too low to use as a de minimis level. Do you agree? If so, what is a better number? Why?

ISSUES FOR WORKSHOP DISCUSSIONS (Cont.)

9. Is delay in dismantlement justified to
a) reduce occupational exposure? b) save money?

10. What level of decommissioning planning should be completed at time of licensing? At time of decommissioning?

ISSUES FOR WORKSHOP DISCUSSIONS (Cont.)

11. Is entombment a viable decommissioning method for nuclides with long half lives, e.g. 20,000 to 80,000 years?

12. Is the NRC technical program adequate in terms of covering the right facilities?

13. Who should pay for decommissioning?
When? How?

ISSUES FOR WORKSHOP DISCUSSIONS (Cont.)

14. The States have advised NRC not to concern itself with the decommissioning of non-radioactive portions of nuclear facilities such as cooling towers at reactor power plants.

Do you agree? Why?