[7590-01]

NUCLEAR REGULATORY COMMISSION

10 CFR Part 20

Radiological Criteria for Decommissioning of NRC-licensed Facilities; Workshops

AGENCY: Nuclear Regulatory Commission.

ACTION: Notice of Workshops.

SUMMARY: The Nuclear Regulatory Commission (NRC) is preparing to initiate an enhanced participatory rulemaking on establishing the radiological criteria for the decommissioning of NRC-licensed facilities. The Commission intends to enhance the participation of affected interests in the rulemaking by soliciting commentary from these interests on the rulemaking issues before the staff develops the draft proposed rule. The Commission plans to conduct a series of workshops to solicit commentary from affected interests on the fundamental approaches and issues that must be addressed in establishing the radiological criteria for decommissioning. The workshops will be held in various locations throughout the United States beginning in January, 1993 and will be open to the public.

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DATES: The schedule for the workshops is as follows:

January 27 and 28, 1993	Chicago, IL.
February 23 and 24, 1993	San Francisco, CA.
March 12 and 13, 1993	Boston, MA.
March 23 and 24, 1993	Dallas, TX.
April 13 and 14, 1993	Philadelphia, PA.
April 29 and 30, 1993	Atlanta, GA.
May 6 and 7, 1993	Washington, D.C. - (National Workshop)

As discussed later in this notice, the workshop discussions will focus on the issues and approaches identified in a Rulemaking Issues Paper prepared by the NRC staff. The Commission will accept written comments on the Rulemaking Issues Paper from the public, as well as from workshop participants. Written comments should be submitted by May 28, 1993.

ADDRESSES: Send written comments on the Rulemaking Issues Paper to: Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555. ATTN: Docketing and Service Branch. Hand deliver comments to 11555 Rockville Pike, Rockville, Maryland between 7:45 a.m. and 4:15 p.m. on Federal workdays. The Rulemaking Issues Paper is available from Francis X. Cameron (See "FOR FURTHER INFORMATION CONTACT").

FOR FURTHER INFORMATION CONTACT: Francis X. Cameron, Special Counsel for Public Liaison and Waste Management, Office of the General Counsel, Washington D.C. 20555, Telephone: 301-504-1642.

SUPPLEMENTARY INFORMATION:

Background

The NRC has the statutory responsibility for protection of health and safety related to the use of source, byproduct, and special nuclear material under the Atomic Energy Act. The NRC believes that one portion of this responsibility is to ensure the safe and timely decommissioning of nuclear facilities which it licenses and to provide guidance to licensees on how to plan for and prepare their sites for decommissioning. Once licensed activities have ceased, licensees are required to decommission their facilities so that their licenses may be terminated. This requires that the radioactivity in land, groundwater, buildings, and equipment resulting from the licensed operation be reduced to levels that allow the property to be released for unrestricted use. Licensees must then demonstrate that all facilities have been properly decontaminated and that radioactive material has been transferred to authorized recipients. Confirmatory surveys are conducted by NRC, where appropriate, to verify that sites meet NRC radiological criteria for decommissioning.

The types of nuclear fuel cycle facilities that will require decommissioning include nuclear power plants; non-power (research and test) reactors; fuel fabrication plants, uranium hexafluoride production plants, and independent spent fuel storage installations. In addition there are currently about 24,000 materials licensees. About one third of these are NRC licensees, while the remainder are licensed by Agreement States acting under the authority of the Atomic Energy Act, Section 274. These licensees include universities, medical institutions, radioactive source manufacturers, and companies that use radioisotopes for industrial purposes. About 50% of NRC's 7,500 materials licensees use either sealed radioactive sources or small amounts of short-lived radioactive materials. Decommissioning of these facilities should be relatively simple because there is usually little or no residual radioactive contamination. Of the remaining 50%, a small number (e.g. radioactive source manufacturers, radiopharmaceutical producers, and radioactive ore processors) conduct operations that could produce substantial radioactive contamination in portions of the facility. These facilities, like the fuel cycle facilities identified above, must be decontaminated before they can be safely released for unrestricted use.

Several hundred NRC and Agreement State licenses are terminated each year. The majority of these licenses involve limited operations, produce little or no radioactive contamination, and

do not present complex decommissioning problems or potential risks to public health or the environment from residual contamination. However, as the nuclear industry matures, it is expected that more and more of the larger nuclear facilities that have been operating for a number of years will reach the end of their useful lives and be decommissioned. Therefore, both the number and complexity of facilities that will require decommissioning is expected to increase.

The Commission believes that there is a need to incorporate into its regulations radiological criteria for termination of licenses and release of land and structures for unrestricted use. The intent of this action would be to provide a clear and consistent regulatory basis for determining the extent to which lands and structures must be decontaminated before a site can be decommissioned. The Commission believes that inclusion of criteria in the regulations would result in more efficient and consistent licensing actions related to the numerous and frequently complex site decontamination and decommissioning activities anticipated in the future. A rulemaking effort would also provide an opportunity to reassess the basis for the residual contamination levels contained in existing guidance in light of changes in basic radiation protection standards and decommissioning experience obtained during the past 15 years.

The new criteria would apply to the decommissioning of power reactors, non-power reactors, fuel reprocessing plants, fuel fabrication plants, uranium hexafluoride production plants, independent spent fuel storage installations, and materials licenses. The criteria would apply to nuclear facilities that operate through their normal lifetime, as well as to those that may be shut down prematurely. The proposed criteria would not apply to uranium (other than source material) mines and mill tailings, high-level waste repositories, or low-level waste disposal facilities.

Until the new criteria are in place, the Commission intends to proceed with the decommissioning of nuclear facilities on a site-specific basis as the need arises considering existing criteria. Case and activity-specific risk decisions will continue to be made as necessary during the pendency of this process.

The Enhanced Participatory Rulemaking

The Commission believes it is desirable to provide for early and comprehensive input from affected interests on important public health and safety issues, such as the development of radiological criteria for decommissioning. Accordingly, the Commission is initiating an enhanced participatory rulemaking to establish these criteria. The objective of the rulemaking is to enhance the participation of affected interests in the rulemaking by

soliciting commentary from these interests on the rulemaking issues before the NRC staff develops the draft proposed rule. The NRC staff will consider this commentary in the development of the draft proposed rule, as well as document how these comments were considered in arriving at a regulatory approach. The Commission believes that this will be an effective method for illuminating the decision making process on complex and controversial public health and safety issues. This approach will ensure that the important issues have been identified; will assist in identifying potential information gaps or implementation problems; and will facilitate the development of potential solutions to address the concerns that affected interests may have in regard to the rulemaking.

The early involvement of affected interests in the development of the draft proposed rule will be accomplished through a series of workshops. A workshop format was selected because it will provide representatives of the affected interests with an opportunity to discuss the rulemaking issues with one another and to question one another about their respective positions and concerns. Although the workshops are intended to foster a clearer understanding of the positions and concerns of the affected interests, as well as to identify areas of agreement and disagreement, it is not the intent of the workshop process to attempt to develop a consensus agreement on the rulemaking issues. In addition to the commentary from the workshop

participants, the workshops will be open to the public and the public will be provided with the opportunity to comment on the rulemaking issues and the workshop discussions at discrete intervals during the workshops.

The normal process for conducting Commission rulemakings is NRC staff development of a draft proposed rule for Commission review and approval, publication of the proposed rule for public comment, consideration of the comments by the NRC staff, and preparation of a draft final rule for Commission approval. In the enhanced participatory rulemaking, not only will comments be solicited before the NRC staff prepares a draft proposed rule, but the mechanism for soliciting these early comments will also provide an opportunity for the affected interests and the NRC staff to discuss the issues with each other, rather than relying on the traditional one-to-one written correspondence with the NRC staff. After Commission review and approval of the draft proposed rule that is developed using the workshop commentary, the general process of issuing the proposed rule for public comment, NRC staff evaluation of comments, and preparation of a draft final rule for Commission approval, will occur.

Participants.

In order to have a manageable discussion among the workshop participants, the number of participants in each workshop must be limited. Based on discussions with experts on workshop facilitation, the NRC staff believes that the optimum size of the workshop group is fifteen to twenty participants. Due to differing levels of interest in each region, the actual number of participants in any one workshop, as well as the number of participants that represent a particular interest in any one workshop, may vary. Invitations to attend the workshops will be extended by the NRC staff using several selection criteria. First, to ensure that the Commission has the benefit of the spectrum of viewpoints on the issues, the NRC staff is attempting to achieve the participation of the full range of interests that may be affected by the rulemaking. The NRC staff has identified several general interests that will be used to select specific workshop participants -- state governments, local governments, tribal governments, Federal agencies, citizens groups, nuclear utilities, fuel cycle facilities, and non-fuel cycle facilities. In addition to these interests, the staff also plans to invite representatives from the contracting industry that performs decommissioning work and representatives from professional societies, such as the Health Physics Society and the American Nuclear Society. The NRC anticipates that most of the participants will be representatives of organizations. However,

it is also possible that there may be a few participants who, because of their expertise and influence, will participate without any organizational affiliation.

The second selection criterion is the ability of the participant to knowledgeably discuss the full range of rulemaking issues. The NRC staff wishes to ensure that the workshops will elicit informed discussions of options and approaches, and the rationale for those options and approaches, rather than simple statements of opinion. The NRC staff's identification of potential participants has been based on an evaluation of such factors as the extent of a potential participant's experience with a broad range of radiation protection issues and types of nuclear facilities, specific experience with the decommissioning issue, and the extent of a potential participant's substantive comment and participation on previous Commission regulatory or licensing actions.

The third criterion emphasizes participation from organizations within the region encompassed by the workshop. As much as practicable, those organizations that primarily operate within the region, as opposed to regional units of national organizations, will have priority in terms of participating in the corresponding regional workshops. Organizations with a national standing will be part of the "national" workshop to be held in Washington, D.C.

Wherever possible, the NRC staff plans to arrange the participation of individual organizations in the workshops through national organizations such as the Organization of Agreement States, and the Conference of Radiation Control Program Directors (CRCPD). There will also be some flexibility to later include organizations who were not originally identified in the staff survey of potential participants. In order to provide the public with information on the types of organizations that may eventually participate in the workshops, the Commission has provided the following summary:

- State governments. The Organization of Agreement States and the CRCPD are willing to coordinate the participation of individual states in the regional workshops. The NRC staff has also notified the National Governor's Association, the Western Governors Association, the National Conference of State Legislatures, and the National Association of Attorneys General of the upcoming workshops.

- Local governments. The NRC staff has contacted the National Association of Counties and the county associations in each state to identify potential local government participants.

- Tribal governments. The NRC staff has contacted three national tribal organizations -- Native Americans for a Clean Environment, the National Congress of American

Indians, and the Council of Energy Resource Tribes -- in regard to the participation of tribal Governments in the regional workshops.

- Citizens groups. The NRC staff has contacted several citizens groups at the national level in regard to their general interest in participating in the national workshop. The groups contacted include the Sierra Club, the Natural Resources Defense Council, the Nuclear Information Resource Service, Public Citizen, U.S. Public Interest Research Group, the League of Women Voters, the National Audubon Society, the Union of Concerned Scientists, and Physicians for Social Responsibility.

  In regard to local and regional citizens groups, the NRC staff has had extensive discussions with the NRC regional personnel, state radiation protection control officials, and others, on potential citizen group participation at the regional level. Based on these discussions, the NRC staff has contacted a number of citizens groups about their potential interest in the enhanced participatory rulemaking.

- Nuclear utilities. The Nuclear Management and Resources Council (NUMARC) will coordinate the participation of utilities in the workshops.

- Fuel cycle facilities. The United States Council on Energy Awareness (USCEA) and the Fuel Cycle Facilities Forum will coordinate the participation of fuel cycle companies in the workshops.

- Non-fuel cycle facilities. The NRC staff has contacted a number of organizations in this category about potential participation in the workshops, including regional radioisotope users groups. The USCEA Committee on Radionuclides and Radiopharmaceuticals assisted in coordinating the participation of the members of these and other non-fuel cycle entities in the workshops. Participants will be drawn from radiopharmaceutical manufacturers, biomedical research radionuclide manufacturers, the medical profession, sealed source manufacturers, and the university research community.

- Decommissioning contractors. In order to ensure that information on decommissioning costs and methods are presented in the workshops, the NRC staff has contacted several of the companies that perform decommissioning work in regard to workshop participation.

- Federal agencies. The NRC staff has contacted several Federal agencies about participation in the workshops. The Environmental Protection Agency (EPA), because of its

expertise and responsibilities, will not only participate in the workshops, but also has been consulted by the NRC staff on the development of the Rulemaking Issues Paper and will be consulted in the evaluation of the workshop comments. EPA has been very supportive of the Commission's enhanced participatory rulemaking and has already provided the NRC staff with assistance on this effort. EPA will be fully involved in the workshops and in providing comments to the NRC staff on the rulemaking issues. It is anticipated that the EPA will also later use the workshop commentary in the development of its regulatory approach for decommissioning. The Commission believes that this consultative approach with EPA will be an efficient way to utilize Federal resources in developing an effective and consistent federal approach to decommissioning standards.

The NRC staff has also had several discussions with the Department of Energy (DOE) about the enhanced participatory rulemaking process and potential DOE participation in the workshops. DOE has indicated a preliminary interest in participating in the national workshop. Although the Commission's decommissioning standards will generally not be directly applicable to DOE facilities, DOE possesses substantial expertise in the decommissioning area that will be a useful source of information in the national workshop. It should be noted that under the Formerly Utilized Site

Remedial Action Program (FUSRAP), and in some other circumstances, DOE may take title to a licensee's or former licensee's site for cleanup and long term care, including monitoring. The NRC staff has also discussed the new rulemaking initiative with several other Federal agencies and interagency coordinating committees. The NRC staff anticipates that federal agency participation will occur in the national workshop.

- Professional societies. The NRC staff has contacted the Health Physics Society, the American Nuclear Society, and other professional societies in regard to their potential interest in participating in the national workshop.

Workshop Location, Schedule, and Format.

The Commission intends to conduct the workshops on a regional basis. Although, there will be one national workshop in Washington D.C. for organizations with a national focus, the rest of the workshops will be held at various locations throughout the United States. The national workshop is not intended to be a summary of the other workshops, and the NRC staff does not intend to give any greater weight to comments made during that workshop than to any other workshop. The regional framework will allow the Commission to hear from as many knowledgeable organizations at the local level as possible. These local organizations will

bring a unique perspective to the discussion of the rulemaking issues, and the regional workshops will also give the NRC an opportunity to interact with organizations with which it has not previously had the opportunity to do so.

The existing NRC regional framework was used to select the workshop locations, with slight adjustments made to accommodate areas with a heightened interest in decommissioning activities, as well as to maximize participation in the workshops. Notification of the specific meeting locations in each of the cities that have been selected as a workshop site will be announced through publication in the Federal Register and letters to individual participants.

To assure that each workshop addresses the issues in a consistent manner, the workshops will have a common pre-defined scope and agenda focused on the Rulemaking Issues Paper discussed below. However, the workshop format will be sufficiently flexible to allow for the introduction of any additional issues that the participants may want to raise. At each workshop, the NRC staff will begin each discussion period with a brief overview of the rulemaking issues to be discussed and the remainder of the workshop will be devoted to a discussion of the issues by the participants. The workshop commentary will be transcribed and made available to participants and to the public.

Personnel from The Keystone Center, a nonprofit organization located in Keystone, Colorado, will serve as neutral facilitators for each workshop. The facilitators will chair the workshop sessions and ensure that participants are given an opportunity to express their viewpoints, assist participants in articulating their interests, ensure that participants are given the opportunity to question each other about their respective viewpoints, and assist in keeping the discussion moving at a pace that will allow all major issue areas to be addressed.

Rulemaking Issues Paper.

The NRC staff has prepared a Rulemaking Issues Paper to be used as a focal point for the workshop discussions. This paper, which will be distributed to participants in advance of the workshops, sets forth in neutral terms the issues that must be addressed in the rulemaking, as well as background information on the nature and extent of the problem to be addressed. In framing the issues and approaches discussed in the Rulemaking Issues Paper, the NRC staff has attempted to anticipate the variety of views that exist on these approaches and issues. The paper will provide assistance to the participants as they prepare for the workshops, suggest the workshop agenda, and establish the level of technical discussion that can be expected at the workshops. The workshop discussions are intended to be used by the staff in developing the draft proposed rule. Prior to the workshops, no staff

positions will be taken on the rulemaking approaches and issues identified in the Rulemaking Issues Paper. As noted earlier, to the extent that the Rulemaking Issues Paper fails to identify a pertinent issue, this may be corrected at the workshop sessions.

The discussion of issues is divided into two parts. First are two primary issues dealing with: 1) the objectives for developing radiological criteria; and 2) application of practicality considerations. The objectives constitute the fundamental approach to the establishment of the radiological criteria, and the NRC staff has identified four distinct possibilities including: 1) Risk Limits, which is the establishment of limiting values above which the risks to the public are deemed unacceptable, but allows for criteria to be set below the limit using practicality considerations; 2) Risk Goals, where a goal is selected and practicality considerations are used to establish criteria as close to the goal as practical; 3) Best Effort, where the technology for decontamination considered to be the best available is applied; and 4) Return to Preexisting Background, where the decontamination would continue until the radiological conditions were the same as existed prior to the licensed activities.

Following the primary issues are several secondary issues that are related to the discussions of the primary issues, but which the NRC staff believe warrant separate presentations and

discussions. These secondary issues include the time frame for dose calculation, the individuals or groups to be protected, the use of separate criteria for specific exposure pathways such as groundwater, the treatment of radon, and the treatment of previously buried materials.

The Rulemaking Issues Paper will be provided to each potential workshop participant. Additional copies will be available to members of the public in attendance at the workshop. Copies will also be available from the NRC staff contact identified above. In addition to the comments on the Rulemaking Issues Paper provided at the workshops, the Commission is also receptive to the submittal of written comments on the rulemaking issues, as noted under the heading "DATES".

Dated at Rockville, MD this 2nd day of December, 1992.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,
Secretary of the Commission

PROPOSED RULEMAKING TO ESTABLISH RADIOLOGICAL CRITERIA FOR DECOMMISSIONING

ISSUES FOR DISCUSSION AT WORKSHOPS

SUMMARY

The Commission proposes to revise 10 CFR Part 20 to include radiological criteria for termination of licenses and release of land and structures for unrestricted use. It is the Commission's intent that the criteria developed in this rulemaking would apply to almost all licensed facilities and sites.[1] However, it would not apply to sites already covered by a Commission approved decommissioning plan. An estimate of the numbers and types of facilities expected to be covered by this rulemaking is provided in the BACKGROUND section of this paper. A discussion of how the Commission proposes to implement the criteria can be found in the section entitled PROPOSED COMMISSION ACTIONS. There may be a small number of sites where cleanup to criteria for unrestricted release developed in this rulemaking may not be practical. The approach to handling such cases is an issue for discussion.

The purpose of this issues paper is to describe the background and issues that would be associated with a rulemaking to establish radiological criteria for decommissioning, and to focus discussions in a series of public workshops on rulemaking issues. The format for each issue is arranged by first describing the general issue to be considered, then providing a background discussion of the issue with potentially useful information for the workshop discussions. A list of sub-issues is also provided.

The description of issues is divided into two parts. First are two primary issues dealing with: 1) the objectives for developing radiological criteria; and 2) the application of practicality considerations. The objectives constitute the fundamental approach to the establishment of the radiological criteria, and the NRC staff has identified four distinct alternatives including: 1) Risk Limits, where a limiting value is selected and criteria are

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[1] The criteria would not apply to the disposition of uranium mill tailings, low-level waste disposal facilities, or high level waste repositories since these have already been addressed in separate regulatory actions. They would apply, however, to uranium mills and ancillary facilities that support radioactive waste disposal (e.g., surface facilities for the high level waste repository).

established below the limit using practicality considerations; 2) Risk Goals, where a goal is selected and practicality considerations are used to establish criteria as close to the goal as possible; 3) Best Effort, where the technology for decontamination considered to be the best available is applied; and 4) Return to Preexisting Background, where the decontamination would continue until the radiological conditions were the same as existed prior to the licensed activities.

Following the primary issues are several secondary issues that are related to the primary discussions, but which were believed to warrant separate presentations and discussions. These include additional considerations such as the time frame for dose calculation, the individuals or groups to be protected, the use of separate criteria for specific exposure pathways such as groundwater, the treatment of radon, and the treatment of previously buried materials.

BACKGROUND

The Nuclear Regulatory Commission (NRC) has the statutory responsibility for protection of health and safety related to the use of source, byproduct, and special nuclear material under the Atomic Energy Act. The NRC believes that one portion of this responsibility is to assure safe and timely decommissioning of nuclear facilities which it licenses, and to provide guidance to licensees on how to plan for and prepare their sites for decommissioning. Decommissioning, as defined by the NRC, means to remove nuclear facilities 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.[2]

Once licensed activities have ceased, licensees are required to decommission their facilities so that their licenses can be terminated. This requires that radioactivity in land, groundwater, surface water, buildings, and equipment

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[2] A glossary of other terms generally used by the NRC can be found in Appendix A.

resulting from the licensed operation be reduced to levels that allow the property to be released for unrestricted use. Licensees must then demonstrate that all facilities have been properly decontaminated and that, except for any residual radiological contamination found to be acceptable to remain at the site, radioactive material has been transferred to authorized recipients. Confirmatory surveys are conducted by NRC, where appropriate, to verify that sites meet NRC radiological criteria for decommissioning.

There are currently about 24,000 licensees in the United States. About one third of these are NRC licensees, while the remainder are licensed by Agreement States through an agreement entered into under the Atomic Energy Act, Section 274. These licensees include universities, medical institutions, radioactive source manufacturers, and companies that use radioisotopes for industrial purposes. About 50% of NRC's 7,500 materials licensees use either sealed radioactive sources or small amounts of short-lived radioactive materials. Decommissioning of these facilities should be relatively simple since there is usually little or no residual radioactive contamination to be cleaned up and disposed of. Of the remaining 50%, a small number (e.g. radioactive source manufacturers, radiopharmaceutical producers, and radioactive ore processors) conduct operations which could produce substantial radioactive contamination in portions of the facility. The population of nuclear fuel cycle facilities which will require decommissioning includes 112 nuclear power plants (at 75 sites); 74 non-power (research and test) reactors; 14 fuel fabrication plants, 2 uranium hexafluoride production plants, 49 uranium mill facilities, and 9 independent spent fuel storage installations. These facilities will have to be decontaminated to acceptable levels before they can be safely released for unrestricted use.

The facilities listed in the NRC's Site Decommissioning Management Plan (SDMP), discussed later in this issues paper, provide an illustration of how a facility or equipment might become contaminated through the use of radioactive material in forms which are not encapsulated to prevent the spread or dispersal of material. Sealed sources, including items such as check sources, do not pose a contamination problem unless the encapsulation is broken. When radioactive material in unsealed forms is used, such as in the nuclear fuel

fabrication industry, in production of radiopharmaceutical medicines, or in research the equipment used to process and handle the material becomes contaminated by the small quantities of material that adhere to surfaces of valves, piping, etc. If material is spilled, then the area of the spill becomes contaminated.

Essentially everything which comes in contact with the radioactive material must be considered as contaminated and checked for the presence of residual radioactive material. Thus areas surrounding facilities could become contaminated by the movement of materials, equipment, and people into and out of the areas containing the radioactive material. NRC requires that contamination control procedures be used to minimize or prevent the movement of radioactive materials into other areas. Nevertheless, some areas may become contaminated over the course of time due to breakdowns in the control procedures. Contamination may also be spread by the movement of water or other fluids containing the radioactive materials through or along pip[illegible] equipment, walls, floors, sumps, drains, etc. In some cases, this ha resulted in significant quantities of radioactive material in the ground under or around buildings and facilities.

In addition to contamination, some licensed operations can produce radioactive materials through the process of activation. Examples of such operations are nuclear reactors. These activated materials can also lead to the need to decontaminate or dispose of the radioactivity during decommissioning.

Several hundred NRC and Agreement State licenses are terminated each year. The majority of these licenses involve limited operations, produce little or no radioactive contamination, and do not present complex decommissioning problems or potential risks to public health or the environment from residual contamination. However, as the nuclear industry matures, it is expected that more and more of the larger nuclear facilities which have been operating for a number of years will reach the end of their useful lives and have to be decommissioned. Thus both the number and complexity of facilities that will require decommissioning is expected to increase.

The NRC has a program underway to effect timely decommissioning of about 40 problem sites which either have not been decommissioned properly or have been engaged in the decommissioning process for an extended time. The Commission has established a Site Decommissioning Management Plan (SDMP) for effecting timely decommissioning of these problem facilities. Sites being handled under the SDMP vary in degree of radiologic hazard, cleanup complexity, and cost. Some sites comprise tens of acres that require assessment for radiological contamination, whereas other sites have contamination known to be limited to individual buildings or discrete piles of tailings or contaminated soil. Many sites involve active licenses, but some sites involve formerly licensed sites, or sites where the responsible party is unable or unwilling to perform cleanup. These sites also vary in degree of completion of decommissioning. At some sites, little or no decontamination work has been done, whereas at other sites, decommissioning plans have been submitted or license termination is in the offing.

The effort to have these SDMP sites cleaned up and decommissioned has been hampered in part because licensees view the absence of definitive decontamination criteria as an incentive to defer decommissioning pending issuance of formal NRC requirements. The General Accounting Office (GAO), which has been critical of the Commission's inability to effect timely decommissioning of these sites, has recommended that NRC enhance its decommissioning efforts by reconsidering its radiological criteria for decommissioning[3].

Until new criteria are in place, the Commission intends to proceed with decommissioning nuclear facilities on a site-specific basis as the need arises considering existing criteria coupled with the concept that residual radioactivity be as low as is reasonably achievable (ALARA). Case and activity-specific decisions concerning decommissioning of sites will continue to be made as necessary during the pendency of this process. Since the SDMP sites could pose unnecessary environmental and public risk or financial burden

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[3] GAO Report to Congress, "NRC's Decommissioning Procedures and Criteria Need to Be Strengthened", GAO/RCED-89-119, May 1989

if they are not cleaned up and decommissioned in a timely manner, the Commission's effort to effect timely decommissioning of these sites is proceeding in parallel with this proposed rulemaking action. The NRC published an Action Plan to ensure timely remediation of sites listed in the SDMP in the Federal Register.[4] It should be noted that as a matter of current policy the NRC does not plan to require additional cleanup of sites in response to criteria established in this rulemaking, provided that the licensee or responsible party cleaned up the site, or was in the process of cleaning up the site in full accordance with an NRC-approved decommissioning plan at the time of promulgation.

Internationally, most efforts have been focussed upon derivation of criteria for waste and recycle, using guidance published by the International Atomic Energy Agency. Decommissioning criteria have generally been established on a case specific basis, and the NRC staff is not aware of other international efforts similar to this rulemaking to define radiological criteria for decommissioning.

NEED FOR RULEMAKING

The Commission believes that there is a need to incorporate into its regulations radiological criteria for termination of licenses and release of land and structures for unrestricted use. The intent of such an action would be to provide a clear and consistent regulatory basis for determining the extent to which lands and structures must be decontaminated before a site can be decommissioned. The Commission believes that inclusion of criteria in the regulations would result in more efficient and consistent licensing actions related to the numerous and frequently complex site decontamination and decommissioning activities anticipated in the future. In addition, a rulemaking effort would also provide an opportunity to reassess the basis for the residual contamination levels contained in existing guidance in light of

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[4]57 FR 13389, April 16, 1992.

changes in basic radiation protection standards[5] and decommissioning experience obtained during the past 15 years.

Current regulations do not explicitly address radiological criteria for decommissioning.[6] Pending NRC rulemaking on generic radiological criteria for decommissioning, the NRC continues to use its current criteria and practices.[7] The NRC could continue to decommission on a site-specific basis using existing guidance. However, the Commission believes that codifying radiological criteria for decommissioning in the regulations would: (1) result in more efficient use of NRC and licensee resources; (2) lead to more consistent and uniform application across all types of licenses; (3) provide a more stable basis for decommissioning planning; and (4) eliminate protracted delays in decommissioning which results as licensees wait for generic regulatory criteria before proceeding with decommissioning of their facilities.

The criteria would apply to the decommissioning of all types of NRC licensed facilities, including materials licensees, power reactors, non-power reactors, fuel reprocessing plants, fuel fabrication plants, uranium hexafluoride

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[5] As codified in the May 21, 1991 revision of 10 CFR Part 20 [56 FR 23360]

[6] In June 1988 the Commission published a final rule on General Requirements for Decommissioning Nuclear Facilities (53 FR 24018, 27 June 1988). However, this rule did not specifically address radiological criteria for decommissioned sites.

[7] Regulatory guidance, criteria, and practices include the following with emphasis on contamination levels that are ALARA: "Disposal or On-site Storage of Thorium or Uranium from Past Operations" Branch Technical Position, October 23,1981, 46 FR 52061; "Termination of Byproduct, Source, and Special Nuclear Materials Licenses", Policy and Guidance Directive FC 83-23, November 4, 1983; Termination of Operating Licenses for Nuclear Reactors" Regulatory Guide 1.86, June 1974 ; letter to Stanford University from James R. Miller, Chief, Standardization and Special Projects Branch, Division of Licensing, Office of Nuclear Reactor Regulation, NRC, Docket No. 50-141, April 21, 1982; "National Primary Drinking Water Standards," 40 CFR 141; "Radiation Dose Guidelines for Protection Against Transuranium Elements Present in the Environment as a Result of Unplanned Contamination," 42 FR 60956, November 30, 1977. Guidance is specified in terms of acceptable levels of residual contamination at decommissioned sites.

production plants, and independent spent fuel storage installations.[8] They would apply to nuclear facilities that operate through their normal lifetime, as well as to those that may be shut down prematurely. There may be a small number of sites where cleanup to criteria for unrestricted release developed in this rulemaking may not be practical. The approach to handling such cases is an issue for discussion.

On July 3, 1990, the Commission published a Below Regulatory Concern (BRC) Policy Statement in the Federal Register. The BRC Policy was intended to guide a broad range of Commission actions, including exemptions from Commission regulations, as well as the development of generic health and safety standards such as those involved in this rulemaking. Subsequent to the publication of the BRC Policy, the Commission placed an indefinite moratorium on the implementation of the BRC Policy because of the broad public concern expressed over the new Policy.[9] After the Commission placed the indefinite moratorium on the implementation of the BRC Policy, it decided to initiate this rulemaking to address the critical need for generic site cleanup and decommissioning standards for NRC-licensed facilities. The Commission determined that it should proceed with a fresh approach to the development of these standards that is independent of the now defunct BRC Policy.

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[8] The criteria would not apply to the disposition of uranium mill tailings, low-level waste disposal facilities, or high level waste repositories since these have already been addressed in separate regulatory actions. They would apply, however, to uranium mills and ancillary facilities that support radioactive waste disposal (e.g., surface facilities for the high level waste repository).

[9] Section 2901 of the recently enacted National Energy Policy Act of 1992 (H.R. 776) revoked the Commission's July, 1990, BRC Policy Statement. Section 2901 also revoked the Commission's policy statement of August 29, 1986 that established criteria to guide Commission exemption decisions on specific low-level radioactive waste streams. This latter policy was developed in order to comply with Section 10 of the Low-level Radioactive Waste Policy Amendments Act of 1985. The Commission will be issuing a formal withdrawal of these two policy statements in the Federal Register in January, 1993.

Concurrent with the NRC rulemaking on site cleanup standards, the Environmental Protection Agency (EPA) is proceeding to develop standards and guidance for Federal agencies in the area of radiation protection, including standards for the cleanup of contaminated sites. The NRC and EPA plan to coordinate their efforts in this area in order to ensure that effective and consistent site cleanup standards are established, while minimizing duplication of effort. Accordingly, the EPA will not only be an important participant in the NRC rulemaking workshops but the NRC also plans to consult extensively with EPA throughout the rulemaking process. It is anticipated that the information gathered during the workshops on the NRC standards will also be relevant and useful to the EPA efforts in the area of site cleanup standards. The NRC will also participate in EPA efforts in this area, such as the activities of the EPA Interagency Working Group on Radiation Protection. The objective of the NRC and EPA cooperative efforts is to attempt to reach an agreement that the NRC standards established in the enhanced participatory rulemaking are sufficient to provide adequate protection to the public health and safety for NRC-licensed sites. The EPA efforts could then focus on the site clean-up standards for non-NRC licensed sites, such as DOE and DOD facilities. This is consistent with the principles and procedures set forth in a recent Memorandum of Understanding between the NRC and EPA to guide each agency's actions in areas of mutual regulatory concern.[10]

PROPOSED COMMISSION ACTIONS

The normal pattern for NRC rulemaking is the development of a proposed rule by the NRC staff for Commission consideration, publication of the proposed rule for public comment, consideration of the comments by the NRC staff, and preparation of a final rule, as appropriate, for Commission approval. As directed and approved by the Commission, the NRC staff plans to enhance

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[10] Federal Register, Vol. 57, 54127, November 16, 1992, "Memorandum of Understanding Between the Nuclear Regulatory Commission and the Environmental Protection Agency"

participation in this process through a series of workshops for interested parties. The workshops are planned to elicit informed discussions of options and approaches, and the rationale for options and approaches. While these workshops are not designed to seek "consensus" in the sense that there is agreement (or at least a lack of disagreement) on the issues, the workshops are to be conducted at a very early stage of rulemaking to enhance participation of interested parties and the public with the following objectives: a) to ensure that the relevant issues have been identified; b) to exchange information on these issues; and c) to identify underlying concerns and areas of disagreement, and, where possible, approaches for resolution. It is the Commission's hope that the interactions that will take place among the participants in the workshop environment will foster a clearer understanding of the positions and concerns of the participants.

The proposed rulemaking activities, if pursued, are expected to result in publication of a proposed rule and a draft Generic Environmental Impact Statement (GEIS). It is the Commission's intent that the criteria developed in this rulemaking would apply to almost all licensed facilities and sites.[11] However, it would not apply to sites already covered by a Commission approved decommissioning plan. An estimate of the numbers and types of facilities expected to be covered by this rulemaking can be found in the BACKGROUND section of this paper.

The Commission intends to publish a Notice of Intent to prepare a GEIS for this rulemaking effort. Separate meetings will be held with interested Federal, state, and local agencies and organizations to discuss the scope of the GEIS. However, information, comments, and suggestions from the discussion of the issues in this paper would be taken into account by the NRC in preparing the GEIS. In addition, one or more Regulatory Guides would be

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[11] The criteria would not apply to the disposition of uranium mill tailings, low-level waste disposal facilities, or high level waste repositories since these have already been addressed in separate regulatory actions. They would apply, however, to uranium mills and ancillary facilities that support radioactive waste disposal (e.g., surface facilities for the high level waste repository).

published to provide licensees with guidance on how licensees could demonstrate compliance with the regulation.

The Commission's plan for implementing the rule is described below. The Commission would issue supporting documents concurrent with the rule which provide guidance on implementation of the residual contamination criteria in the rule. These documents would include a "Guidance Manual for Conducting Radiological Surveys in Support of License Termination" (NUREG/CR-5849) and a Technical Basis Document, "Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual TEDE" (NUREG/CR-5512). The Guidance Manual for Conducting Radiological Surveys is intended to provide licensees with specific guidance on planning, conducting, and documenting site surveys which could be used to demonstrate that the site has been decontaminated to a level consistent with the Commission's criteria. The Technical Basis Document would provide an acceptable method for translating residual radioactivity levels (measurable quantities) to doses to individuals. Generic dose rate conversion factors are being developed for screening. In addition, the technical basis is expected to include a computer model which can be used for conducting a screening scenario/pathway analyses with site-specific parameters so that site-specific dose rate conversion factors can be calculated. The NRC anticipates that in most cases these dose rate conversion factors could be used to determine compliance with criteria resulting from the rulemaking action.

Work on the supporting documents is already underway, and drafts are available for information. However, these documents are not intended to constrain the approach taken by the Commission in developing radiological criteria. Instead, they are intended to provide a technical underpinning which would be useful irrespective of the approach or the criteria finally adopted by the Commission. These documents will be revised as necessary to conform to the final criteria.

In addition to the activities directly supporting a rulemaking action on decommissioning criteria, the NRC has a number of other related activities in progress in the general area of decommissioning. These activities include:

(1) rulemaking to define the timeliness of decommissioning, and (2) rulemaking to require licensees to list in one location all land, buildings, and equipment involved in licensed operations. These activities will not be specifically considered as part of the discussions on radiological criteria for decommissioning.

ISSUES FOR DISCUSSION

Before the Commission formally proposes to proceed with rulemaking as described above, it is prepared to consider a wide range of alternative approaches, including maintaining the status quo. The basic question before the Commission is, "What level or levels of risk, dose, residual radioactivity, or other decommissioning criteria, would provide acceptable protection of health and safety and the environment?" The answer to this question must be reasonable and practical to implement and to enforce for the broad range of facilities which require decommissioning.

The Commission believes that the key issues and sub-issues discussed below are at the foundation of the basic question posed above. Therefore, the Commission solicits comments and information on these issues before proceeding with a proposed rulemaking. These issues, and other relevant and substantial issues identified by interested parties, will serve as the basis of discussion at a series of workshops. Workshop participants will be expected to present the rationale for their preferences and positions in the workshop setting. The workshop discussions will be used by the NRC staff in developing a proposed rule or, if considered appropriate, pursuing an alternative strategy for decommissioning.

The discussion of issues is divided into two parts. First are two primary issues dealing with the objectives for developing radiological criteria, and the application of practicality considerations. Following these issues are several secondary issues that are related to the primary discussions, but which were believed to warrant separate presentations and discussions. The format of discussion for each issue is arranged by first describing the general issue to be considered, then providing a background discussion of the

issue with potentially useful information for the workshop discussions. A list of sub-issues is also provided to focus the discussions. It is important to recognize that the Commission does not regulate natural background or fallout from weapons or other sources beyond its authority. Therefore, the following decommissioning issues are to be considered as they apply to radioactivity that is both attributable to licensed operations and is above background levels.

The Commission does not intend to include the issue of Agreement State compatibility with NRC requirements as a topic for discussion in the workshops. The Commission has a concurrent process to establish a general policy on compatibility and does not believe it would be efficient to have two separate forums focussing on the same subject. The Commission believes that the ongoing process to establish the general policy on compatibility would be the more appropriate forum to discuss all compatibility issues. In addition, parties will be afforded the opportunity to comment on compatibility issues at the time of the publication of a proposed decommissioning rulemaking. This approach will allow the workshops to focus upon the central technical issues and approaches to the radiological criteria for decommissioning.

PRIMARY ISSUES FOR DISCUSSION

Issue I: What objective(s) should serve as the basis for establishing radiological criteria for decommissioning?

Discussion:

There are four fundamental kinds of objectives that could serve as the starting point for developing radiological criteria for decommissioning (i.e., release for unrestricted use). They are described briefly below.

1. RISK LIMITS--Establishment of limits above which the risks to the public are deemed unacceptable. The objective in this case would be to find a limit above which risks would be unacceptable, and then establish

additional criteria to further reduce exposures to levels below the unacceptable to the extent practical. With this objective, a site could be released for unrestricted use if there were reasonable assurance or demonstration that members of the public would not be exposed to an unacceptable risk from radioactivity remaining at the site.

In practical terms this objective would mean that the radioactivity remaining at the site must be below some upper limit established by the NRC as representing the boundary of unacceptable exposure to an individual or group of individuals. Below this upper limit, exposures would be further reduced to levels which are "As Low As Reasonably Achievable" (ALARA) taking into account various factors of practical implementation (cost versus benefit), and socioeconomic considerations. (See Issue 2)

2. RISK GOAL--Establishment of risk goals below which the risks to the public are deemed trivial. This objective would be to find a level of public and environmental risk below which risks are considered trivial, and then require decontamination to levels which are either below the goal, or as close to those goals as practical. Using this objective, a site would be released for unrestricted use if the radioactivity remaining at the site were as close as practical to the goals selected. If the decontamination goals were met or exceeded, then no further consideration of decontamination would be required.

In practical terms, residual radioactivity levels greater than the corresponding risk goals would be accepted provided they are as close as reasonably achievable to the risk goals. If the levels of radioactivity were below the levels corresponding to the goals, then no decontamination would be required, regardless of feasibility.

3. BEST EFFORT -- Best effort emphasizing use of available technology. The objective in this case would be to establish criteria representing what is achievable using the "best" available technology. A site would be released for unrestricted use if the only residual radioactivity

remaining at the site is that material which cannot be removed using the best available technology. This objective is technologically driven. Theoretically, it could lead to removal of all radioactivity attributable to licensed activities or to an undefined level limited by the efficiency of the technology. Cost can be a factor, but is not taken into consideration on the basis of cost versus benefit balancing.

4. RETURN TO BACKGROUND LEVELS. This objective would be to remove all radioactivity attributable to licensed activities. A site would be released for unrestricted use only if all radioactivity attributable to licensed activity were removed. This objective could be difficult to implement either because of the costs associated in reducing residual radioactivity to background levels or because of the difficulty in demonstrating that a return to background levels had been achieved. Demonstrating a return to background levels could be especially difficult at sites where the background levels were not recorded prior to beginning licensed operations, or at facilities licensed to use nuclides such as uranium or thorium which already exist in varying degrees in the natural background.

The following information is provided to aid discussion and is focused first on the Risk Limits and Risk Goals objectives and secondly on the Best Effort and the Return to Background objectives:

The fundamental principle underlying all NRC regulations and activities has been that radiation doses to members of the public from licensed activities must be reduced to levels established as limits (Risk Limits objective).[12] The limits pose the boundary of unacceptable public risk regardless of the cost required to achieve such reduction, and risks should be further reduced to levels which are ALARA. This principle is articulated in 10 CFR Part 20, and the Commission currently uses this principle as the basis for decommissioning nuclear facilities. For example, the typical practice in

[12]Although NRC regulations are designed to limit risk, not all limits in the regulations were established on the basis of risk.

decontaminating an area is to remove contamination through sweeping, washing, chemical stripping, scabbling thin layers of concrete, etc. The area is then surveyed and the results compared to the appropriate established criteria. If the area does not meet the criteria, then further steps are taken to reduce the level of radioactivity remaining. Once the levels are met, then further steps are considered to lower the remaining levels, but the decision to use these steps take into account the costs of the step and the reduction that is anticipated. This principle is also the basis for certain actions by the Environmental Protection Agency in the area of radiation protection, and is a fundamental principle outlined in both national and international recommendations.

In its recent recommendations on radiation protection, the International Commission on Radiological Protection (ICRP) has introduced the concept of a "constraint" in establishing the appropriate level of protection for any particular source of radiation exposure such as a decommissioned facility.[13] A constraint is a selected level, below the dose limit (the dose limit corresponds to an acceptable risk), to provide assurance that any given individual would not receive a dose in excess of the dose limit, even if that individual were to be exposed to several sources simultaneously. As described by the ICRP, the concept of ALARA would be applied after the constraint was met. This approach is similar to the approach already utilized by the NRC in establishing criteria for effluents from nuclear power plants in 10 CFR Part 50 Appendix I and by the Environmental Protection Agency in the generally applicable environmental standards such as 40 CFR Part 190 and in 40 CFR Part 61, the regulations implementing the Clean Air Act.

The Risk Goals objective was recently applied by the Environmental Protection Agency in the selection of values for radionuclides in drinking water. In its proposal, the EPA established maximum contaminant level goals (MCLGs) for radionuclide levels, then established maximum contaminant levels (MCLs) which were greater than the goals in recognizing factors such as availability of

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[13]International Commission on Radiation Protection, ICRP Publication 60, November 1990.

technology, costs to remove radionuclides, and numbers of individuals involved. This is an extreme application of the risk goal principle, because the risk goal was legislatively set equal to zero. It is recognized that these goals may not be literally achievable. Furthermore, confusion has resulted from failure to distinguish between levels and goals.

In addition, several national and international agencies and organizations, including the NRC, have adopted or proposed numerical risk or dose levels for public exposure from activities and practices involving radioactive materials. These risk levels may provide a basis for initiating a dialogue on numerical levels of risk or dose which would provide an acceptable basis for establishing radiological criteria for decommissioning. In addition, EPA has established or proposed other risk objectives that should be considered, such as EPA standards related to the Clean Air Act, the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as "Superfund") which may need to be considered in establishing criteria. For example, the EPA has established health based limits for numerous chemicals under RCRA. On May 20, 1992, (57 FR 21450) the EPA published a proposed rulemaking on the identification of hazardous waste which included, as an option, the use of multiples of these health based limits in determining the appropriate approach to management of the waste as hazardous or other solid waste. Although The proposed approach has been withdrawn, EPA plans to continue assessing the merits of approaches used by others (57 FR 49280, October 30, 1992).

The Commission's current radiological criteria for decommissioning, are stated in terms of acceptable levels of residual contamination and external dose rates at one meter from contaminated surfaces. These criteria have been conservatively estimated, considering the most highly exposed population group of individuals, to result in potential doses ranging between one and several

tens of millirem per year Total Effective Dose Equivalent (TEDE/y) (exclusive of doses from radon and its daughter products).[14]

The EPA Clean Air Act and regulations provide practical examples of the application of the Best Effort regulatory principle. Among other things, the Clean Air Act requires the EPA Administrator to set new standards for emission of air pollutants based on the best, adequately demonstrated, technological system, taking into account the cost of achieving emission reduction, energy requirements, and any non-air impacts on the quality of health and the environment. Another section of the Clean Air Act permits the EPA Administrator, based on the same considerations as listed above, to set standards based on a design, equipment, work practice, or operational standard, or combination of these.[15] The EPA uses several implementing concepts in promulgating Clean Air Act regulations, including maximum achievable control technology (MACT), generally available control technologies (GACT), and best demonstrated technology (BDT), and each of these concepts include considerations of cost and other factors listed in the Clean Air Act.[16] These terms are defined in Appendix B.

The Return to Background objective for clean-up of facilities has been applied particularly for chemical hazards which do not normally exist in nature, and the approach often taken is to establish the clean-up objective at zero contaminants. In situations where some type of background, or natural concentrations of chemicals already exist, such as contaminants in a groundwater aquifer, the objective is sometimes expressed in terms of non-

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[14] For some radioisotopes (e.g., ^{238}U), acceptable residual levels may be based on non-radiological effects (e.g., the chemical toxicity of uranium) if the non-radiological effects are potentially more hazardous than the radiological effects.

[15] Public Law 101-549 (104 STAT. 2399) November 15, 1990, (Clean Air Act Amendments of 1990, Sections 111 and 112).

[16] For examples, see 56 FR 64382, December 9, 1991, "National Emission Standards for Hazardous Air Pollutants for Source Categories: Perchloroethylene Emissions From Dry Cleaning Facilities," (Proposed Rule), and 55 FR 26953, June 29, 1990, "Standards of Performance for New Stationary Sources; Volatile Organic Compound (VOC) Emissions From the Synthetic Organic Chemical Manufacturing Industry (SOCMI) Reactor Processes" (Proposed Rule).

degradation of the existing situation, meaning that no additional materials should be present beyond those already existing.

There may be some sites where the cost of meeting the selected criteria would be exorbitant. Consideration should be given to the disposition of such sites. Such sites could be handled in a manner similar to, or reflect elements of, the way the Commission deals with uranium mill tailings sites under the provisions of the Uranium Mill Tailings Radiation Control Act of 1978, As Amended (UMTRCA). Under the provisions of UMTRCA, mill tailings sites are partially decontaminated, stabilized, and subject to requirements for restricted use and long-term care and are not released for unrestricted use. EPA's CERCLA/Superfund Program also allows cost to be a consideration in site cleanup; however, cost is typically not a primary consideration in setting environmental levels under RCRA or the Clean Water Act (CWA). Implementation under these programs is primarily focussed on "Best Demonstrated Available Technology" (BDAT).

The NRC has several possible approaches to codifying radiological criteria for decommissioning. One approach is to establish limits in terms of dose in the regulation and then provide listings of specific residual radioactivity levels for different radionuclides either as an appendix to the regulation or as a Regulatory Guide. This is the approach of 10 CFR Part 20 for the dose limits, where the values in Appendix B of Part 20 serve as a method for demonstrating compliance with the dose limit, rather than being a limit themselves. Alternatively, the Commission could codify specific values for residual radioactivity for each radionuclide of concern as part of the regulation. Similarly, a Risk Goal could be codified in terms of a dose or a risk, or alternatively, as specified levels of radioactivity. If the chosen decommissioning objective were Best Effort, then the method of determining the appropriate technology could be codified or the technology itself could be codified. For the Return to Natural Background objective, the method for determining background and accuracy of determinations could be the substance of the regulation or quantitative levels of radioactivity could be codified.

The terms of the regulation could be important to the extent that they could affect the Commission's flexibility in applying the regulation and also the flexibility the licensees would have in demonstrating compliance. If objectives were codified in terms of specific measurable quantities such as concentrations of radioactive materials, neither the Commission nor the licensees would have flexibility to take site specific factors into account when trying to demonstrate compliance. However, if the objective were codified, individual licensees could conduct a site specific analysis to demonstrate to the Commission that their site would meet the objective with different residual radioactivity levels than those determined by the Commission based on a generic, conservative analysis.

Past experience has shown that changes to the regulations containing specific criteria are much more difficult to complete and require more resources than if the criteria are contained in a Regulatory Guide. However, past experience has also shown that enforcement of specific, measured values is unambiguous, direct, and unencumbered by lengthy litigation.

Sub-issues:

1. At what numerical level would the regulatory objective for decommissioning provide an acceptable basis for protection of the public health and safety and the environment?

   a. If the Commission chooses a Risk Limit objective, should the Commission use the public dose limits in 10 CFR 20 (100 mrem/y) as the limit on doses from residual radioactivity at decommissioned sites or establish separate constraints for decommissioning? If separate constraints are set, what should be the basis for these constraints?

   b. If the Commission chooses a Risk Goal objective as its basis for establishing criteria, on what basis should the goal be established?

   c. If the Commission chooses a Best Effort objective as its basis for establishing criteria, what level of technological availability should

be used? How often should the applicable areas of technology be updated for this criteria? What criteria should govern the number of applications of the technology to achieve lower levels of residual radioactivity, i.e., how would the point of diminishing returns be established? Recognizing that application of technology could result in widely varying levels of residual radioactivity, should an additional limit be placed on the level of residual radioactivity? If new technologies become available that are significantly more efficient in decontaminating a site, should these new technologies be applied to previously decommissioned sites? If so, what criteria should require the reopening of a site for decontamination?

d. If the Commission chooses the Return to Background objective as a basis for establishing criteria, how should background levels of radiation and radioactive material be established? For example, should a single level be chosen for each naturally occurring radionuclide, or should the local level of background be used, or some other criterion? How should the chosen approach, single or local level, be measured and to what accuracy?

2. What other alternatives should be considered as a general framework for establishing objectives? Should the Commission consider combinations of the fundamental objectives and if so, which combinations and on what basis?

3. What role should EPA initiatives play in setting objectives? For example, the EPA used about a 10^{-4} lifetime risk of fatal cancer for members of the most highly exposed population group and a general lifetime risk level on the order of 10^{-6} as a basis for National Emission Standards for Hazardous Air Pollutants.[17] Are there other established or proposed risk objectives that should be considered?

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[17] 40 CFR Part 61, "National Emission Standards for Hazardous Air Pollutants; Radionuclides." Final Rule and Notice of Consideration, 54 FR 51654, December 15, 1989

4. What consideration should be given to standards or objectives proposed or adopted by other groups (e.g. International Atomic Energy Agency, (IAEA))?

5. What should be done in those cases where sites cannot reasonably be decontaminated to the point where they are appropriate for unrestricted use?

6. How prescriptive should the regulation on radiological criteria for decommissioning be? For example, should the Commission codify the decommissioning objective(s) and provide details (e.g., residual radioactivity concentration, etc.) of a method of compliance elsewhere, such as in a Regulatory Guide, or should the regulation be more prescriptive?

Issue II. How should practicality considerations be applied,particularly if the Commission were to adopt either the Risk Limit objective or the Risk Goal objective in its radiological criteria for decommissioning rule?

Discussion:

ALARA is an acronym for as low as is reasonably achievable and means making every reasonable effort to reduce or maintain exposures to radiation as far below established dose limits as is practical taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvement in relationship to the benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of nuclear energy and licensed material in the public interest. This covers a broad spectrum of actions and activities including cost-benefit analysis of procedures and proposals, availability and application of measurement technologies, and availability of disposal facilities. The same factors that have been traditionally used in radiation protection (Risk Limit objective based) are also the factors that would be used in determining how close practical criteria can be made to a Risk Goal objective. Thus, in the present context, the term ALARA can be used to represent the practical process (that is, cost versus benefit evaluation process) of reaching either the lowest acceptable

risk below an Risk Limit or the lowest risk above a Risk Goal as discussed in Issue I.

The employment of practicality considerations, including costs, availability of technology, etc., has been recognized as valid in a number of contexts, both in the area of radiation protection and in the regulation of hazardous chemicals and wastes. For example, in recommendations approved by the President on Radiation Protection Guidance to Federal Agencies for Occupational Exposure, the concept of ALARA was specifically included.[18] Likewise, the EPA has acknowledged the validity of considering costs and benefits in determining levels for regulation of chemicals in various arenas, as illustrated by the EPA response to a petition requesting revocation of food additive regulations.[19] The NRC rulemaking is being conducted under the Atomic Energy Act, which allows consideration of ALARA, provided the public health and safety are protected.

There are a variety of ways the principle of ALARA can be applied. In both the Risk Limit and Risk Goal objectives, ALARA can be applied on a case-by-case basis with a site-specific analysis required for each site. Alternatively, generic ALARA criteria could be established which would be applicable to all sites or to categories of sites. This latter alternative is equivalent to combining both the Risk Limit and the Risk Goal objectives.

A credible ALARA analysis must consider all of the costs and benefits associated with decontaminating a site to different residual radioactivity levels and must be carefully documented to demonstrate that all reasonable alternatives and technologies have been considered. It should take into account: (1) radiation doses (public and occupational) and environmental impacts both from the process of decommissioning the site and from the residual radioactivity which will remain at the site after it has been decommissioned, and (2) all of the costs and other risks (e.g. occupational,

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[18]52 FR 2822, January 27, 1987.

[19]56 FR 7750, February 25, 1991.

transportation) associated with the decontamination and decommissioning the site. It should also include an analysis which clearly demonstrates how overall costs and benefits change with changing residual radioactivity levels. The analysis must be properly documented. This should include documentation of the methodology and the sources of data used in the analysis, and include an assessment of the uncertainties associated with the results of the analysis. ALARA analyses can be carried out on either a generic or site specific basis. Generic analyses by their very nature will produce results with higher uncertainty than those that can be obtained from a site specific analysis. Therefore, a more conservative approach would have to be adopted when conducting a generic analysis to assure that the results of the analysis are appropriate to all of the sites and activities to which the analysis is expected to apply.

Sub-issues:

1. Should the Commission require that ALARA be determined on a site-specific basis for each site to be decommissioned? If not, how should ALARA be applied? Should the Commission establish generic ALARA criteria (i.e., Meeting the generic criteria would be considered ALARA for any site without need for further site specific cost versus benefit analysis.)? If generic ALARA criteria are used, should a single ALARA criterion be established for all sites, or should different ALARA criteria be established for different categories of sites or facilities. If ALARA criteria are established for different categories of sites, on what basis should the different categories be established?

2. Irrespective of whether ALARA is applied on a site-specific basis or generically, on what basis should the ALARA analysis rest? What level of review by the NRC staff should be required to evaluate this basis? For example, if a cost versus benefit analysis were to be used, what monetary value per averted collective dose (i.e. dollars/person-rem) should the Commission use as a basis for making the determination? How should the level of difficulty in measuring certain radionuclides in some circumstances be

handled? How should the staff address societal and socioeconomic aspects of the ALARA analysis?

SECONDARY ISSUES FOR DISCUSSION

Secondary Issue A.: What additional considerations should be taken into account when establishing radiological criteria for decommissioning?

Discussion:

In developing criteria, there is often a question of exactly who the standard is designed to protect. For example, the criteria may be established to protect a theoretical, maximally exposed individual, regardless of whether such an individual could actually exist. Alternatively, the criteria could be established on the basis of providing protection for more realistically exposed individuals, and could include consideration of a so called "critical group" which would be a small number of individuals that are representative of that population likely to receive the greatest dose. A "critical group" approach would often mean that it would be possible for the exposure of some single individual to be greater than the average of the group, and therefore experience a dose or risk in excess of the criteria.

Related to the question of the characteristics of the individual to be protected is the question of whether protecting individuals assures that the population, as a whole, that might be exposed is adequately protected. Various positions have been advanced on this subject, with some indicating that protection of each individual automatically assures protection of the population as a whole, and others indicating that additional criteria might be needed to protect the population. The hypothesis usually used for the regulation of radiation dose is a linear relationship between dose and risk, implying that an increment of dose, no matter how small, and no matter when delivered, will have an equal impact. This reasoning has been used to support

the position, in some cases, that an additional criterion should be applied to the collective dose from a particular facility or source. On the other hand, each decommissioned facility can only expose a limited number of people.

In developing criteria for decommissioning, the codified definition of decommissioning, i.e. to reduce radioactive materials levels to a point where the site is suitable for unrestricted use, becomes important. Once a site has been released, an individual or group could use the property and any structures on the property in any legally acceptable way they wished, including renovating the structures for other purposes, excavation or other property modifications, and removal of materials from the site for use in other locations or for other purposes. Thus, when considering the appropriate criteria for unrestricted use, consideration may also need to be given to the potential for reuse, recycling, or disposal of structures or materials remaining on the site.

An additional consideration in the selection of radiological criteria is the time frame over which the criteria should be applied. There have been a number of different values suggested and used in various standards of the NRC and EPA, ranging from 100 years to over 10,000 years. For radionuclides with relatively short half-lives, decay negates the need for evaluations in the distant future. However, for long-lived radionuclides, and particularly for chains of radionuclides where daughter products will gradually increase until equilibrium is reached (e.g., uranium and thorium), the time frame for considerations is potentially important. Time periods are also important when certain pathways, such as a groundwater pathway, are considered, since the movement of radionuclides through the pathway may be very slow under certain circumstances.

Sub-issues:

1. Should the Commission base its considerations on a theoretical, maximally exposed individual, or upon some type of "critical group" approach? What endpoint(s), such as cancer fatalities or cancer incidence, genetic effects, etc., should be used in establishing the radiological criteria?

2. Should the Commission include consideration of an exposed population in addition to providing criteria for individuals? If so, how should this influence the criteria?

3. Should the Commission consider the potential, after release for unrestricted use, for reuse of building structures and the removal of soil from a site in determining the appropriate criteria? If so, how should these factors be included? Should the removal of materials lead to a different standard than if materials were to remain on the site? If so, what is the rationale or basis? Should consideration be given to consistency or linkage with waste disposal regulations, particularly in situations where large quantities of material may require removal during the decommissioning process?

4. How far into the future should calculations be carried out when making estimates and determining the applicability of criteria? Should the Commission place a maximum value on the time frame to be considered, or should the criteria be applicable irrespective of time as which a maximum exposure could occur? For low levels of radioactivity should other changes in the environment, such as global warming and ice age cycles, geologic changes, etc., be factored into considerations of the applicability of the criteria?

Secondary Issue B.: If the objective the Commission adopts is either the Risk Limit or the Risk Goal, how should the regulation be structured with respect to exposure pathways? Should the rule apply comprehensively to all major pathways (routes) of exposure to the public or should the rule have criteria to limit specific exposure pathways, such as radionuclides in groundwater?

Discussion:

This issue arises because, over long periods of time residual radioactivity from decommissioned sites could contaminate groundwater that would later be used for drinking or irrigation. Furthermore, groundwater could be contaminated from more than one decommissioned site if another site were

nearby. The Environmental Protection Agency has established limits for radioactivity in drinking water[20] and, under the authority of RCRA and CERCLA, applies these limits to most potable ground water, but there are no Federal standards for groundwater contamination at decommissioned facilities.

In 10 CFR Part 20, the Commission has adopted the International Commission on Radiation Protection (ICRP) recommendations to account for doses from all pathways in one term. The Commission combines the doses from external exposures, ingestion and inhalation into the term, "Total Effective Dose Equivalent" (TEDE). That is, there is an internationally recognized methodology for weighing the doses and combining them into a single number, TEDE, that enables comparison of doses regardless of the pathway of exposure--external, ingestion or inhalation.[21]

Conceptually, the NRC could establish an overall limit or goal for a site, and allow the contribution (dose or risk) from each pathway of exposure (e.g. air, water, direct radiation, food) to vary so long as the total remained consistent with the overall limit or goal. Alternatively, a secondary limit or goal in addition to the overall criterion could be established to limit the extent to which a particular pathway could contribute to the total. A third possibility is that separate criteria could be established for each particular exposure pathway, independent from each of the other pathways.

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[20] 40 CFR Part 141. EPA regulations are applied to public water systems and not individual users. For beta and/or gamma emitters the dose to the whole body or an organ is limited to 4 mrem/y, while for alpha emitters Maximum Contaminant Levels are set in terms of pCi/l and exclude radon and uranium. The EPA has published a proposed revision of these regulations, expressed in terms of a 4 rem/y effective dose equivalent (see 56 FR 33050). The proposed revision also includes specific limits on radon and uranium.

[21] For example, the technical basis document translating radioactivity in the environment to dose (PROPOSED COMMISSION ACTIONS section above, p. 9) accounts for radiation doses from major sources originating in soil, air, and water and combines the respective pathway doses into a conversion factor for TEDE.

If a separate limit or goal were chosen for groundwater, then details of the method for estimating doses or risk due to water use at future times after decommissioning would be required. One method could be to establish Generic Site Inventory Levels[22], as a screening criterion based upon an analysis for a generic site. The basis for this approach could be that residual radioactivity from sites meeting these generic screening levels would not be expected to contaminate drinking water supplies in excess of EPA standards under any reasonably foreseeable circumstances regardless of the type of facility, or size, location, or hydrogeologic features of the site. Such an approach would also need to consider the possibility that building structures remaining onsite at the time of unrestricted release could be demolished and become part of the overall site inventory available to the groundwater. It is noted that Generic Site Inventory Levels that provide a reasonable margin of safety for all sites are likely be extremely restrictive and thus impractical for some sites. Potential impracticality could be addressed by providing licensees who demonstrate that Generic Site Inventory Levels are unnecessarily restrictive for their particular site with the option of conducting a site specific analysis to project compliance with EPA drinking water standards or other criteria specified in the rule.

Sub-issues:

1. What consideration should be given to the potential for cumulative drinking water contamination from two or more decommissioned sites in the same general area?

2. If specific exposure pathway criteria were chosen, which pathways should have specific criteria and on what basis should these criteria be established?

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[22] A Generic Site Inventory Level would be total amount of radioactive material from the licensed operation which could be left at a decommissioned site without having to conduct a site specific analysis to determine whether allowing this radioactive material to remain at the site might result in unacceptable contamination of drinking water supplies.

3. If the Commission chooses specific criteria for groundwater or water use, should it establish Generic Site Inventory Levels for screening residual radioactivity at decommissioned sites? Should the basis for such levels be to provide reasonable assurance that EPA drinking water standards will not be exceeded? Should a single Generic Site Inventory Level be established for all sites, or should levels be tailored to specific class of decommissioned sites (e.g., all nuclear power plant sites)? If so, on what basis should sites be categorized? Alternatively, should the Commission require that a site specific assessment of drinking water contamination potential be carried out for each site or a combination of the above?

Secondary Issue C.: For sites where uranium, radium or thorium contamination may have resulted from licensed activities, how should exposures from radon (^{222}Rn and ^{220}Rn) and its decay products be considered when the facility is decommissioned?

Discussion:

Small quantities of uranium, radium and thorium are present in all soil types throughout the United States. These naturally occurring materials are responsible for part of the natural background radiation exposure to members of the public, and are precursors for radon gas--the single greatest contributor to natural background exposures. Because radium occurs naturally in the environment, accurate determinations of doses from radon resulting from licensed operations can be very difficult. First, radium from licensed operations contaminating building structures will produce radon within the structure. This radon will be in addition to radon present due to naturally occurring radium within or under the building. Radon concentrations from natural sources in buildings are known to be variable, and may be subject to variations due to factors such as building ventilation, weather, etc. Secondly, a fraction of the radium in the soil of the site could be from licensed operations and could contribute to indoor radon levels of any building later constructed on the site. The correlation between soil concentrations of uranium, radium or thorium have been shown to be not well

correlated with the eventual levels of radon within a building. Given the above factors, approximate estimates of the amounts of uranium and thorium and their decay products (including radium) on site as a result of licensed operations might be made by taking direct measurements at a site in conjunction with offsite measurements to establish background levels. However, the estimation of indoor radon concentrations attributable to licensed operations for the present and future structures appears elusive.[23]

Based on information available to the NRC, there appears to be no practical way, using current technology, to distinguish between small amounts of radon from licensed operations and that radon resulting from natural background. This inability appears to be due to (1) the natural background levels of radium in rocks and soils and the resulting concentrations of radon[24], (2) the variability of doses at a given site from naturally occurring radon[25], and (3) the difficulty in correlating indoor radon levels with the concentrations of radon in the soil outside the structures.[26] There are some who believe it may be virtually impossible to demonstrate that doses from

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[23]Radon may also be a problem for a licensee that has never possessed materials containing uranium or thorium if they are located in an area of elevated natural radon levels. In these cases an individual in the structure could receive doses in excess of the criteria for decommissioning from sources outside the original responsibility of the licensee.

[24] Soil radium concentrations in the U.S. average about 1.5 pCi/g. The average indoor radon concentration is about 1.5 pCi/l which produces an estimated dose to a resident (assuming 75% occupancy) of about 150 mrem/y. EPA Radon Reference Manual, EPA 520/1-87-20, September, 1987, pp.3-5 and 7-2.

[25] The transport of radon through the environment is subject to considerable uncertainty and variability. In the case of indoor radon, variables such as highly localized geology, structural features, and changing weather, among others, combine to make accurate prediction of doses very difficult.

[26] As is the case for transport of radon through the environment, there are considerable uncertainties in the modeling of the movement of radon into a structure and the concentrations of radon that will exist at any given time. Numerous studies have shown that seemingly identical structures in similar environments can nevertheless have considerably different radon concentrations.

radon which result from licensed operations have been reduced to levels much below the EPA suggested action level of 4 pCi/l for indoor radon.[27]

Sub-issues:

1. For sites where licensed activities have involved uranium, thorium, or other materials which decay to radon, are there practical and reliable ways to distinguish between radon and its daughter products attributable to residual radioactivity from licensed operations at a site and that radon attributable to natural background? Are there methods for estimating such doses with reasonable assurance using modelling techniques, direct measurements, or some combination of the two? At what dose levels can these distinctions be made?

2. If there is no way of distinguishing doses from radon resulting from licensed operations at levels well below the 100 mrem annual limit for public doses (10 CFR Part 20.1301), what alternatives would be considered acceptable? For example, would it be acceptable to require the licensee to demonstrate the site had been cleaned up to levels approaching ambient background levels measured at nearby representative sites or buildings? Would this alternative be acceptable even when these background levels would result in doses which are a large fraction of, or even exceed 10 CFR Part 20 limits for the public (100 mrem/y)?

3. Should the Commission consider criteria similar to existing EPA guidelines and standards even though these doses may be higher than the public dose limits in the revised 10 CFR Part 20 (100 mrem/y)? Alternatively, should the Commission require licensees to reduce doses from radon and its daughter products as far below the EPA standard as reasonably achievable? How would compliance with such a requirement be judged (see Issue II)?

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[27] The level at which EPA suggests action be taken to reduce radon concentrations in homes. See "A Citizen's Guide to Radon, 2nd Edition - "The Guide to Protecting Yourself and Your Family from Radon", 402-K92-0001, Office of Air and Radiation; U.S. Environmental Protection Agency, June,1992.

4. How should the Commission handle radon exposures in excess of EPA guidelines in facilities of licensees that have never possessed uranium, radium, or thorium materials?

Secondary Issue D.: How should the Commission regard materials previously buried on-site under disposal provisions in 10 CFR Part 20 in the context of decommissioning?

Discussion:

Under certain conditions, licensees may dispose of radioactive wastes by burial on their own property. Before 1981, NRC regulations (10 CFR 20.304) allowed disposal, without prior approval, of limited quantities of specified nuclides under prescribed conditions. On July 28, 1981, 10 CFR 20.304 was revoked. However, onsite disposal can still be undertaken by individual licensees under 10 CFR 20.302, provided the disposal is specifically approved by the NRC or an Agreement State.

NRC requirements in 10 CFR 20.302 and 20.2002 allow licensees to request specific approval to dispose of licensed radioactive material in a manner not otherwise authorized by the regulations. In accordance with 10 CFR 20.2002, any such request must be accompanied by specific data and analyses necessary for the staff to determine whether such disposal would have an adverse effect on the health and safety of the public or the environment. The radioactive material involved in the requests is generally very low activity waste contained in large volumes of material, such as sludge from sanitary sewers and storm drains, soils contaminated by spills and leaks, and dredged material from discharge canals and settling ponds.

The requirements in 10 CFR Part 20 do not explicitly limit the quantity or concentration of the radioactive material. Past practices have limited approvals to small concentrations of radioactive material and correspondingly low to very low potential doses to members of the public and the environment.

Maximum potential doses have generally been less than a few millirem per year.

Sub-issues:

1. When preparing their sites for decommissioning, should licensees be required to consider radioactive materials disposed of on-site in accordance with provisions of NRC or Agreement State regulations as part of the total inventory of residual radioactivity that must be considered when preparing a site for decommissioning?

2. Should a site specific analysis of the risks, costs, and benefits be performed before a decision is made to take any remedial action (e.g. exhumation and removal of buried radioisotopes, or delaying release of a site to allow decay of short lived buried radioisotopes) involving radioactive material previously disposed of at a site?

APPENDIX A

A GLOSSARY OF GENERAL TERMS USED BY THE NRC[28]

Activity (Radioactivity) is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

ALARA (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Background radiation means radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission.

Byproduct material means --

(1) 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; and

(2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution

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[28] 10 CFR Part 20.1003 [56 FR 24018, May 21, 1991]

extraction operations do not constitute "byproduct material" within this definition.

Collective dose is the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Commission means the Nuclear Regulatory Commission or its duly authorized representatives.

Committed dose equivalent ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed effective dose equivalent ($H_{E,50}$) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \Sigma\, w_T H_{T,50}$).

Dose or radiation dose is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dose equivalent (H_T) means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

Effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma w_T H_T$).

Exposure means being exposed to ionizing radiation or to radioactive material.

External dose means that portion of the dose equivalent received from radiation sources outside the body.

Generally applicable environmental radiation standards means standards issued by the Environmental Protection Agency (EPA) under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

Government agency means any executive department, commission, independent establishment, corporation wholly or partly owned by the United States of America, which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government.

Individual means any human being.

Internal dose means that portion of the dose equivalent received from radioactive material taken into the body.

License means a license issued under the regulations in Title 10, Code of Federal Regulations, Parts 30 through 35, 39, 40, 50, 60, 61, 70, or 72.

Licensed material means source material, special nuclear material, or byproduct material received, possessed, used, transferred or disposed of under a general or specific license issued by the Commission.

Licensee means the holder of a license.

Limits (dose limits) means the permissible upper bounds of radiation doses.

Member of the public means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

Monitoring (radiation monitoring, radiation protection monitoring) means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

Nonstochastic effect means health effects, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

NRC means the Nuclear Regulatory Commission or its duly authorized representatives.

Occupational dose means the dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

Public dose means the dose received by a member of the public from exposure to radiation and to radioactive material released by a licensee, or to another source of radiation either within a licensee's controlled area or in unrestricted areas. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

Radiation (ionizing radiation) means alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and

other particles capable of producing ions. Radiation, as used in this part, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Site boundary means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

Source material means--

(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or

(2) Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

Special nuclear material means--

(1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or

(2) Any material artificially enriched by any of the foregoing but does not include source material.

Stochastic effects means health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or pre-

sence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Total Effective Dose Equivalent" (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted area means an area, access to which is neither limited nor controlled by the licensee.

Uranium fuel cycle means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel to the extent that these activities directly support the production of electrical power for public use. Uranium fuel cycle does not include mining operations, operations at waste disposal sites, transportation of radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and byproduct materials from the cycle.

Whole body means, for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

APPENDIX B

TERMS AND CONCEPTS ASSOCIATED WITH THE BEST EFFORT (TECHNOLOGY-BASED) APPROACH PUT FORTH IN THE CLEAN AIR ACT[29]

Best Available Control Technology (BACT) - An emission limitation based on the maximum degree of emission reduction which (considering energy, environmental, and economic impacts and other costs) is achievable through application of production processes and available methods, systems, and techniques. In no event does BACT permit emissions in excess of those allowed under any applicable Clear Air Act provisions. Use of the BACT concept is allowable on a case by case basis for major new or modified emissions sources in attainment areas and applies to each regulated pollutant.[30]

Best Demonstrated Technology (BDT) - The technology on which the EPA will base the standards, i.e., application of the best technological system of continuous emission reduction which (taking into account the cost of achieving such emission reduction, and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.[31]

Generally Available Control Technologies (GACT) - The EPA Administrator may elect under certain circumstances to promulgate standards or requirements which provide for the use of generally available control technologies or management practices to reduce emissions of hazardous air pollutants.[32]

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[29] Public Law 101-549 (104 STAT. 2399) November 15, 1990, (Clean Air Act Amendments of 1990).

[30] "EPA Glossary of Environmental Terms and Acronym List", OPA-87-017, August 1988.

[31] Clean Air Act Amendments of 1990, Section 111(a)(1)

[32] Clean Air Act Amendments of 1990, Section 112(d)(5)

Maximum Achievable Control Technology (MACT) - Emissions limitations based on the best demonstrated control technology or practices in similar sources to be applied to major sources emitting one or more of the listed toxic pollutants.[33]

Residual Risk - The quantity of health risk remaining after application of the MACT (Maximum Achievable Control Technology).[34]

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[33] Glossary of Terms - Clean Air Act Amendments of 1990

[34] Glossary of Terms - Clean Air Act Amendments of 1990