INTRODUCTION

FIRST: As I mentioned earlier, we have three seminal papers that will occupy the rest of the morning, and I do call your attention to these papers because I think they are opening new ground. They are of extreme interest at present and will continue to be into the future. The first of these papers will be presented by Dr. Ronald Bellamy. Many of you know Ron, he's been a constant attender and contributes at these Conferences since he left Ohio State University and joined the Nuclear Regulatory Commission. Because his doctoral thesis work was in activated carbon, he came to AEC headquarters at an opportune time with all the knowledge and assurance of a newly minted Ph.D. A nice thing about Ron is his consistency, he is still very positive and he has maintained his enthusiasm and elan through the years. He is my very valued colleague. He is presently Chief of the Decommissioning and Laboratory Branch in Region One of the Nuclear Regulatory Commission. He is on the ASME and ASTM committees on standards and on the Program Committee for this Conference. He's a visiting lecturer at Harvard University and lectures in the course that I am associated with, the In-place Filter Testing Workshop, as well as Dade Moeller's course on Nuclear Emergency Preparedness issues.

AIR CLEANING ISSUES WITH CONTAMINATED SITES

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Abstract

The US Nuclear Regulatory Commission has developed a list of contaminated sites that warrant special USNRC attention because they pose unique or complex decommissioning issues. This list of radiologically contaminated sites is termed the Site Decommissioning Management Plan (SDMP), and was first issued in 1990. A site is placed on the SDMP list if it has;

1. Problems with the viability of the responsible organization (e.g., the licensee for the site is unable or unwilling to pay for the decommissioning;
2. Large amounts of soil contamination or unused settling ponds or burial grounds that may make the waste difficult to dispose of;
3. The long-term presence of contaminated, unused buildings;
4. A previously terminated license; or
5. Contaminated or potential contamination of the ground water from on-site wastes.

In deciding whether to add a site to the SDMP list, the NRC also considers the projected length of time for decommissioning and the willingness of the responsible organization to complete the decommissioning in a timely manner. Since the list was established, 9 sites have been removed from the list, and the current SDMP list contains 47 sites in 11 states. The USNRC annually publishes NUREG-1444, "Site Decommissioning Management Plan", which updates the status of each site.

This paper will discuss the philosophical goals of the SDMP, then will concentrate on the regulatory requirements associated with air cleaning issues at the SDMP sites during characterization and remediation. Both effluent and worker protection issues will be discussed. For effluents, the source terms at sites will be characterized, and measurement techniques will be presented. Off-site dose impacts will be included. For worker protection issues, air sampling analyses will be presented in order to show how the workers are adequately protected and their doses measured to satisfy regulatory criteria during decontamination operations.

Introduction

The cleanup of radiological contamination, both within the property of a licensee, and in the general environs as a result of licensee operation, is a major challenge facing the nuclear industry. In recognition of this focus of activity, the NRC formally acknowledged several contaminated sites to promote timely and safe cleanup of these sites and provide special NRC attention because they pose unique or complex decommissioning issues. This list is presently composed of 47 sites in 11 states. In addition, numerous other sites are undergoing or have completed decontamination efforts and have been decommissioned. Some of these are active licensees, while others are formerly-licensed sites from as long as 40 years ago. The methods used to review the decontamination activities, and the acceptance criteria, should be well-defined and understood so that achievable goals are acknowledged and used in the activities. The specified end-points for the cleanup

activities used to release areas for unrestricted use should be readily available to the technical experts, and the public alike, open to public scrutiny, and, as generic as possible.

The Site Decommissioning Management Program

NRC developed the Site Decommissioning Management Plan (SDMP) in 1990 to identify a list of contaminated sites that warrant special NRC attention because they pose unique or complex decommissioning issues. While none of these sites represent an immediate threat to the public health and safety, they have contamination that exceeds criteria for release for unrestricted use. All of these sites require some degree of remediation, and several involve regulatory issues that will need to be addressed by the NRC Commissioners. These problematic sites have buildings, former waste disposal areas, large piles of tailings, groundwater, and soil contaminated with low levels of uranium or thorium (source material) or other radionuclides. Consequently, they present varying degrees of radiological hazard, remediation complexity, and cost. Some of the sites are still under the control of active NRC licenses, whereas, licenses for other sites already may have been terminated or never may have been issued. At some sites, licensees are financially and technically capable of completing decommissioning in a reasonable timeframe, whereas, at other sites, the licensee or responsible party may be unable or unwilling to perform decommissioning. In addition, the sites are currently in various stages of decommissioning. At some sites, licensees have initiated decommissioning, whereas, at other sites, decommissioning has not yet been planned or initiated. Sites are placed on the SDMP if there are:

(1) Problems with the viability of the responsible organization (e.g., the licensee for the site is unable or unwilling to pay for the decommissioning;
(2) Large amounts of soil contamination or unused settling ponds or burial grounds that may make the water difficult to dispose of;
(3) The long-term presence of contaminated, unused buildings;
(4) A previously terminated license; or
(5) Contamination or potential contamination of the groundwater from on-site wastes.

In deciding whether to add a site to the SDMP list, the NRC also considers the projected length of time for decommissioning and the willingness of the responsible organization to complete the decommissioning in a timely manner. Since the list was established, 9 sites have been removed from the list, and the current SDMP list contains 47 sites in 11 states. The USNRC annually publishes NUREG-1444, "Site Decommissioning Management Plan", which updates the status of each site. The list was established in 1990, and 9 sites have been removed after successful completion of cleanup to meet requirements, or transferred to another regulatory authority. There are eight major activities associated with any major decommissioning activity. Progress can be measured against these milestones.

(1) A characterization of the site, which would identify the amount and location of radioactive material. A characterization plan is part of this activity, the performance of the characterization, and preparing the characterization report;
(2) Regulatory review and approval of the site characterization plan and the site characterization report;
(3) Development and submission of a decommissioning plan, outlining the steps to be taken to perform the decontamination activities;

(4) Regulatory review and approval of the decommissioning plan;
(5) Performance of the decontamination and decommissioning activities outlined in the plan;
(6) Performance of a final status survey to verify releasability of the site and submittal of a final status survey report;
(7) Regulatory review of the termination survey report, and performance of a confirmatory survey;
(8) Termination of the license.

Radiological Criteria for Decommissioning

Generally, licensees decommission their facilities with the intent of terminating the license and using the facility for activities that do not involve licensed material. The ultimate goal of decommissioning is to reduce residual radioactivity to levels that are indistinguishable from background levels. These facilities must be decommissioned such that they do not contain residual radioactive material levels in excess of criteria for unrestricted use. The radiological criteria for unrestricted use are identified in the "Action Plan to Ensure Timely Remediation of Sites Listed in the Site Decommissioning Management Plan", 57 FR 13389, April 16, 1992. These criteria include the following:

- USNRC Policy and Guidance Directive FC 83-23, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Byproduct, Source and Special Nuclear Material Licenses", November 14, 1983;
- Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", June 1974;
- Options 1 and 2 of the Branch Technical Position, "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations" 46 FR 52601, October 23, 1981;
- 40 CFR Part 141, Interim National Primary Drinking Water Regulations;
- EPA's "Radiation Dose Guidelines for Protection Against Transuranium Elements Present in the Environment as a Result of Unplanned Contamination".

These criteria are applied on a site-specific basis with emphasis on remediating residual radioactive material to levels that are as low as reasonably achievable. In addition, these criteria will be considered in establishing site-specific ALARA levels for SDMP sites in license amendments and orders. Further, implementation of residual contamination criteria is dependent on the establishment of acceptable dose or risk criteria for unrestricted use of nuclear facilities.

The Policy and Guidance Directive and the Regulatory Guide provide criteria in terms of fixed and removable contamination and acceptable radiation exposures associated with beta-and gamma-emitting surface contamination. The guidance also provide acceptable volumetric concentrations of uranium, thorium, americium and plutonium in soil. The Branch Technical Position, published in the Federal Register on October 23, 1981, 46 FR 52061, provides acceptable activity concentrations of uranium and thorium (with and without decay products) in soil under a variety of conditions.

The Environmental Protection Agency's (EPA's) Interim National Primary Drinking Water Regulations, 40 CFR Part 141, July 9, 1976, 41 FR 38404, provides maximum contaminant limits for radionuclides in public drinking water, which can be extended to apply as acceptable activity concentration in groundwater and surface water. These documents provide guidelines for acceptable average and maximum surface contamination levels for a wide variety of radionuclides. Also provided are average and maximum radiation levels of 0.2 and 1.0 millirad per hour at 1 centimeter for beta and gamma-emitters. In addition, an acceptable external radiation exposure rate for soil contamination of 10 microroentgen above background per hour at one meter is specified.

Regulatory Guide 1.86

When these acceptable surface contamination levels are combined with an exposure rate limit of 5 μR/hr above background at 1 meter, this guide has been used in decommissioning and terminating licenses for a number of research reactors. The 5 μR/hr criterion for indoor contamination corresponds to an annual whole body dose of about 10 millirem for an assumed indoor occupancy period of 2000 hours per year. The 5 μR/hr criterion has been applied to ^{60}Co, ^{137}Cs, and ^{152}Eu that may exist in concrete, components, and structures at nuclear reactor research facilities, with an overall dose objective of 10 millirem/year.

The Branch Technical Position (BTP) on Disposal or Storage of Thorium and Uranium Wastes, 46 FR 52061 provides guidance on decommissioning and cleanup of fuel cycle and other facilities contaminated with relatively large volumes of waste with low activity concentrations of uranium and thorium. In combination with the disposal provisions in 10 CFR 20.302, the technical position provides four "options" for disposal of uranium and thorium wastes, which vary in activity concentration and corresponding potential radiological dose. Only the lower-activity concentration limits and disposal methods provided in Options 1 and 2 of the technical position can be applied as criteria for the release of a site for unrestricted use. Options 3 and 4 require deed restrictions, in effect releasing a site for restricted use.

Under Option 1 of the Branch Technical Position, licensees may dispose of wastes containing natural thorium, depleted or enriched uranium, and natural uranium without restrictions for burial method or post-termination land use. The activity concentrations for this option are consistent with the levels identified in Table I. The maximum activity concentration for natural uranium is based on EPA standards for cleanup and stabilization of uranium mill tailings for ^{226}Ra (5 pCi/g) including its decay products (42 FR 2556-2563). The activity concentrations for natural thorium and depleted or enriched uranium are based on internal radiation dose guidelines recommended by the EPA for protection against transuranium elements present in the environment as a result of unplanned contamination (42 FR 60956-60959). As shown in Table 1, committed doses are expected to be on the order of one millirad per year to the lung or three millirad per year to the bone from inhalation and ingestion. The resulting concentrations would also limit external exposures to less than 10 μR/hr above background.

Under Option 2 of the 1981 BTP, concentrations of natural thorium and depleted or enriched uranium are required to be buried under prescribed conditions without requiring land use restrictions after license termination. Disposals performed under Option 2 guidelines must be covered by four feet or more of clean soil. Acceptable activity concentrations for burial were calculated based on

the criteria that (1) radiation doses to members of the public should not exceed Option 1 levels when the waste is buried in an approved manner under routine exposure conditions, and (2) radiation doses to an inadvertent intruder should not exceed 170 millirems to a critical organ or whole body.

When applying Option 2 of the technical position, the human intruder pathway is evaluated. In addition, consistent with the technical position, groundwater considerations are also evaluated, when necessary, because of site specific hydrogeologic features and groundwater use. Dose from the groundwater pathway should not exceed 3 mrad/yr to the bone (approximately 1.8 mrem/yr effective-dose-equivalent) consistent with the stated dose basis for the Option 1 concentration values. Dose from the human intruder pathway should not exceed 170 mrem/yr to the critical organ. For soluble uranium, the critical organ is the bone. For insoluble uranium, the critical organ is the lung. For thorium, both soluble and insoluble, the critical organ is the whole body.

The dose of 170 mrem/yr to the whole body, from Option 2 concentrations of thorium, via the human intruder pathway, may be unacceptably high. Further, this 170 mrem/yr whole body dose assumes 0.8 occupancy factor and a 0.5 shielding factor. If the occupancy and shielding factors are set to 1, the dose from thorium may be as high as 420 mrem/yr to the whole body. Therefore, for thorium concentrations above the Option 1 limit, the 10 CFR 20 limit of 100 mrem/yr total effective dose equivalent may be the appropriate unrestricted-use release limit. The intruder exposure pathway could possibly be ignored when the disposal method makes the chance of future human access very remote, such as via deep disposal, or disposal by mine backfill. Disposals under Option 2 that involve depleted or enriched uranium are evaluated for buildup of decay products for a period of 1000 years. The original dose assessments to determine the Option 2 limits for depleted and enriched uranium did not include decay products because the decay products are removed in processing the uranium. Significant ingrowth of the decay products requires more than 1000 years and has not been routinely considered in assessing the acceptability of the disposal under Option 2 even though potential doses may increase considerably with time (i.e., beyond 10,000 years).

TABLE I

Contamination	Criteria	Dose Basis
Average, fixed U-nat, ^{235}U, ^{238}U,	5000 dpm/100 cm^2	13 mrem/yr
Average, fixed ^{226}Ra, ^{228}Ra, transuranics, etc.	100 dpm/100 cm^2	0.2 mrem/yr
Average, fixed Th-nat, ^{232}Th, Sr, etc.	1000 dpm/100 cm^2	28 mrem/yr
Avg. and max. external beta-gamma dose	0.2-1 mrad/hr at 1 cm	20 mrem/yr
U-nat with decay products in soil	10 pCi/gm	2.4 mrem/yr
Depleted Uranium in soil	35 pCi/gm	1.8 mrem/yr
Th-nat with decay products in soil	10 pCi/gm	35 mrem/yr
Enriched Uranium in soil	30 pCi/gm	1 mrad/yr to lung 3 mrad/yr to bone
^{239}Pu in soil	25 pCi/gm	15 mrem/yr
^{241}Am in soil	30 pCi/gm	19 mrem/yr
External radiation	10 μR/hr at 1 meter above background	24 mrem/yr

Listing of Sites

The sites currently on the Site Decommissioning Management Plan include the following:

Advanced Medical Systems, Inc., Cleveland, OH
Aluminum Company of America, Cleveland, OH
Anne Arundel County/Curtis Bay, Anne Arundel County, MD
Army, Department of, Aberdeen Proving Ground, Aberdeen, MD
Army, Department of, Jefferson Proving Ground, Jefferson, IN
Babcock & Wilcox, Apollo, PA
Babcock & Wilcox, Parks Township, PA
BP Chemicals America, Inc., Lima, OH
Brooks & Perkins, Detroit, MI
Brooks & Perkins, Livonia, MI
Cabot Corporation, Boyerton, PA
Cabot Corporation, Reading, PA
Cabot Corporation, Revere, PA
Chemetron Corporation, Bert Avenue, Cleveland, OH
Chemetron Corporation, Harvard Avenue, Cleveland, OH
Clevite, Cleveland, OH
Dow Chemical Company, Bay City and Midland, MI
Elkem Metals, Inc., Marietta, OH
Englehard Corporation, Plainville, MA
Fansteel, Inc., Muskogee, OK
Hartley and Hartley (Kawkawlin) Landfill, Bay County, MI
Heritage Minerals, Lakehurst, NJ
Horizons, Inc., Cleveland, OH
Kaiser Aluminum, Tulsa, OK
Kerr-McGee, Cimarron, OK
Kerr-McGee, Cushing, OK
Lake City Army Ammunition Plant (formerly Remington Arms Co., Independence, MO)
Minnesota Mining and Manufacturing Co., (3M), Pine County, MN
Molycorp, Inc., Washington, PA
Molycorp, Inc., York, PA
Northeast Ohio Regional Sewer District/Southerly Plant, Cleveland, OH
Nuclear Metals, Inc., Concord, MA
Permagrain Products, Media, PA
Pesses Company, METCOA Site, Pulaski, PA
RMI Titanium Company, Ashtabula, OH
RTI, Inc., (formerly Process Technology of North Jersey, Inc.), Rockaway, NJ
Safety Light Corporation, Bloomsburg, PA
Schott Glass Technologies, Duryea, PA
Sequoyah Fuels Corporation, Gore, OK
Shieldalloy Metallurgical Corporation, Cambridge, OH
Shieldalloy Metallurgical Corporation, Newfield, NJ
Texas Instruments, Inc., Attleboro, MA
Watertown Arsenal/Mall, Watertown, MA

Watertown GSA, Watertown, MA
Westinghouse Electric Corporation, Waltz Mill, PA
Whittaker Corporation, Greenville, PA
Wyman-Gordon Company, North Grafton, MA

The nine sites that were formerly on the list, but have been removed are:

Allied Signal, Teterboro, NJ
AMAX, Inc., Washington Bottom, WV
Budd Co., Philadelphia, PA
Chevron Corp, Pauling, NY
Magnesium Electron, Flemmington, NJ
Old Vic, Inc., Cleveland, OH
United Nuclear Corp., Wood River Junction, RI
Pratt & Whitney, Middletown, CT
West Lake Landfill, Bridgeton, MD

Formerly-Licensed Sites Identified As Potentially Contaminated

In 1976, the General Accounting Office (GAO) raised concerns about the decommissioning of sites formerly licensed by the Atomic Energy Commission's (AEC's) regulatory body, which is now the Nuclear Regulatory Commission (NRC). In its response, NRC agreed to reexamine the files of the terminated licenses. Between 1977 and 1982, Oak Ridge National Laboratory (ORNL) reviewed the docket files for all fuel cycle and materials licenses terminated before 1965 to verify that all sites had been properly decommissioned. This was done under an interagency agreement with the NRC. The files of 16,230 former licensees were reviewed and a total of 12 contaminated sites were identified. All of the 12 sites had been licensed pursuant to 10 CFR Part 40 and none represented a significant risk to public health and safety. NRC took action to have former licensees decontaminate seven of the sites. The Department of Energy (DOE) accepted responsibility for the other five sites under its Formerly Utilized Site Remedial Action Program (FUSRAP).

In 1989, GAO issued a report on NRC decommissioning procedures and criteria. This report raised additional concerns about the decommissioning of formerly-licensed sites. Before testimony presented to the House Subcommittee on Environment, Energy, and Natural Resources, a commitment was made to review the records of all sites terminated since 1965. ORNL was contracted again to review all docket files retired between 1965 and 1985. This second study required the creation of a computerized inventory of the docket files in addition to screening the files to determine whether all licensed sites had been properly decommissioned. If documentation were inadequate to verify that a formerly-licensed site had been properly decommissioned, the status of the site was to be verified by inspection. It was subsequently decided to review the files of all terminated licenses (Pre-1965 and Post-1985) using the same screening criteria and to document their status in one computer inventory. This would improve information retrieval and permit comparison of the review findings for all terminated license files.

The objective of the review was to evaluate the likelihood and possible magnitude of contamination at formerly licensed materials sites. In its review, ORNL used license files and related files (e.g., inspection and correspondence files) to obtain information relevant to the

possibility of site contamination. The information was entered into a database and evaluated by an expert system that prompts the reviewer to enter additional data and judgements. For the sake of efficiency, the system first determined whether the license could be eliminated for administrative reasons, e.g., it was superseded by another license or it was transferred to an Agreement State. There is a provision to override this determination if the site had the potential for serious contamination based on materials possessed.

The system next assigned a score based on the nuclides and quantities the licensee was authorized to possess. This score considered the form of the material, inhalation and ingestion dose factors, and decrements for half-life. Some licenses were eliminated from consideration on the basis that they had small quantities of materials, only low-hazard materials, or materials that would have decayed to below levels of concern. The score was modified by information disposition, and by indications of possible contamination of equipment, structures, or the environment (releases, burials, incineration, operational incidents).

Using this system, ORNL has reviewed the files of over 31, 000 materials licenses. Scores from zero to as high as almost 500,000 were assigned. For 622 sites (or 2%), there was sufficient question about the documentation in the files to warrant further examination of the license. Scores greater than 300 were given first priority, then, scores less than 300 and then, sealed source files. Requests to the former licensee, current site owner or occupant, Agreement Sates, and NRC staff were made regarding concerns about the sites. Site visits have been required to resolve some concerns, including radiological surveys. If contamination above release limits is found, remedial actions are decided on, and responsible parties identified.

Approximately 10% of the 600 sites are being found to contain contamination above release limits for unrestricted use. Some of these sites have been cleaned up, others added to the SDMP (and in the case of Pratt-Whitney, since removed), and others are awaiting further action. This process is ongoing and is not expected to be complete until at least 1997.

Timeliness of Actions

Throughout the United States, there are approximately 7,000 licensees authorized to use nuclear materials. Each specific license expires at the end of the day listed on the license, unless a renewal is requested. If a license expires, or is terminated, it is the licensee's responsibility to initiate any necessary decontamination and decommissioning efforts, at their expense, to return the property to such a condition that it can be released for unrestricted use. Financial responsibilities are discussed in the following section.

Decommissioning begins (license status is changed from active to decommissioning) if any of the following occur:

(1) The license expires or is revoked;
(2) The licensee decides to permanently cease operations with licensed material at the entire site, or in any separate building or outdoor area that contains residual radioactivity, such that the area is not releasable in accordance with NRC requirements;

(3) Twenty-four months have elapsed since principle activities have been conducted under the license; or
(4) No principle activities have been conducted in a separate building, or outdoor area, for a period of 24 months and residual activity is present that would preclude release of the area in accordance with requirements.

Once any of the above occur, the licensee is required to notify NRC in writing, and begin decommissioning the facility, or within 12 months submit a decommissioning plan and begin decommissioning according to the plan once approved.

Regulations discussing these timeliness actions are contained in 10 CFR 30.36(d) (1-4), 40.42(d) (1-4), 70.38(d) (1-4) and 72.54(d) (1-4). The effective date of the rule was August 15, 1994, (59 FR 36026, July 15, 1994).

For licensees with unused facilities on August 15, 1994, the following submittals are required by August 15, 1996:

(1) Within 12 months of submitting the required notification of decommissioning, they are to submit a decommissioning plan (if required) and begin decommissioning upon approval of the plan;
(2) Unless otherwise approved, they are to complete decommissioning within 24 months of initiating decommissioning;
(3) If notification was made prior to August 15, 1994, no further notification is required; and
(4) Those licensees that made prior notification were required to submit a decommissioning plan, or request an alternative decommissioning schedule by August 15, 1995.

Extensions may be granted to these time periods in accordance with 10 CFR 30.36(e), 40.42(e), 70.38(e), and 72.54(s) (1). The extension must not be detrimental to the public health and safety and otherwise, in the public interest, considering:

(1) Whether it is technically feasible to complete the decommissioning in the 24-month period;
(2) Whether sufficient waste capacity is available to complete the decommissioning in the 24-month period;
(3) Whether a significant volume reduction in waste requiring disposal and radiation exposures to workers will be achieved by allowing short-lived isotopes to decay, and
(4) Other site-specific factors, such as the requirements of their regulatory agencies, lawsuits, groundwater issues, actions resulting in more environment harm than deferred cleanup, and other factors beyond the control of the licensee.

These actions are all designed to ensure that sites are decommissioned and released for unrestricted use in a timely manner, and that the responsible parties and the regulatory authorities ensure these actions occur.

Timeliness Rule for Former Radioactive Waste Burials

Prior to 1981, general licensees were allowed to bring radioactive waste on their property in accordance with 10 CFR 20.304 and 20.302. No regulatory approval was required for this action. The decommissioning timeliness rule discussed above applies to these sites, and current property owners need to assess these burials and possibly remediate them based on current regulatory release criteria for unrestricted use. However, this position was not clearly explained in 1989 with the promulgation of the Timeliness Rule, as mentioned in previous 10 CFR 20 regulations. Sites will need to be reviewed to ascertain existing information about the radionuclide content, concentration and total activity, the location and design of the burial, and applicable environmental characteristics important to waste isolation. Radionuclide concentrations and quantities below the threshold values of Table I do not warrant additional investigation, and these former burial areas are suitable for release without land use restrictions. Additional characterization may be needed to:

(1) Assess the type, concentration, and total activity of radionuclides in the waste;
(2) Determine environmental characteristics to estimate long-term fate and transport of radionuclides; and
(3) Evaluate the potential for human intrusion into the waste and associated exposure characteristics.

The goal is to ensure that doses to members of the public will be a small fraction (e.g., 10-20 mrem/year) of the 100 mrem/year public dose limit in 10 CFR 20.1301. Stabilization or exhumation and disposal may be necessary if projected doses exceed a small fraction of the public dose limit.

Compliance with these decommissioning timeliness requirements may be difficult since universities and research institutions may not be aware of the requirements. There may be considerable cost to comply. The safety significance associated with the burial sites may not be high. It may not be possible to identify and notify the large number of property owners who own sites where former licensees may have conducted authorized burials. And finally, the Decommissioning Timeliness Rule only applies to present licensees. Non-licensed, responsible parties will be encouraged to meet the decommissioning schedules discussed in the timeliness Rule.

Financial Assurance

In addition to identifying a responsible party for decontamination and decommissioning activities, and criteria for release for unrestricted use, an assurance of adequate financial resources is a key component is an overall decommissioning process. In recognition of this, regulations have been promulgated at 10 CFR 30.35, 40.36, and 70.25, with the purpose of assuring that decommissioning for licensed facilities will be accomplished in a safe and timely manner and that adequate licensee funds will be available for this purpose, such that, the financial burden and responsibility does not rest with the taxpayer.

Financial assurance is based on the radioisotopes allowed to be possessed by the licensee, and the possession limits. Financial Assurance is not required for licenses involving radionuclides with half-lives less than 120 days. Possession limits for financial assurance requirements for materials licenses are based on Appendix B to 10 CFR Part 30. For a licensee that only possesses sealed sources, and in amounts greater than 10^{10} times the quantities in Appendix B, financial assurance in the amount of $75,000 is required. For licensees with materials in unsealed form and greater than 10^3 but less than 10^4 times the quantities in Appendix B, financial assurance in the amount of $150,000 is required. For licensees with materials in unsealed form greater than 10^4 but less than 10^5 times the quantities in Appendix B, financial assurance in the amount of $750,000 is required. If the quantity in unsealed form exceeds 10^5 times the Appendix B quantities, a decommissioning funding plan is required.

A decommissioning funding plan outlines the work required to decommission a facility, provides a site-specific cost estimate for the decommissioning, and states that funds necessary to complete the decommissioning have been obtained. In general, the cost estimate should provide for decommissioning the facility to allow unrestricted release. The estimate should assume that the work will be performed by an independent, third party contractor and not take credit for salvage value or reduced taxes. However, for certain sites where the licensee provides a viable alternative approach, or alternative basis for the cost estimate, the plan may be approved if the approach provides sufficient assurance of funding for decommissioning. Licensees may demonstrate financial assurance for decommissioning by one or more of the following mechanisms:

(1) Prepayment - a deposit at the start of operation in a segregated account outside of the licensee's control. Prepayment mechanisms include trust funds, escrow accounts, certificates of deposits and government securities;
(2) Surety, Insurance, or Parent Company Guarantee Method - assurance that the cost of decommissioning will be paid by another party should the licensee default on the responsibility to complete the decommissioning. In addition to insurance, surety methods may include payment surety bonds, letters of credit, lines of credit and parent company guarantees;
(3) External Sinking Fund - a sinking fund account plus insurance or surety mechanism, such that the total of both at least equals the cost of decommissioning. A sinking fund is a segregated account outside of the licensee's control and any of the prepayment mechanisms may be used to hold the assets for the sinking fund account.

In addition, Federal, State or Local Government licensees may provide financial assurance for decommissioning with a statement of intent. A statement of intent is a statement from the appropriate government entity indicating that decommissioning funds will be obtained when necessary. Such statements need to state the estimated cost of decommissioning, as well as a demonstration that the party signing the statement has the authority to make such a statement on behalf of the government. In limited cases, a private licensee may rely on a government statement of intent if it is part of a binding contract between the government and the licensee.

The objective of NRC's financial assurance requirements are to ensure that a suitable mechanism for completing the decommissioning of licensed facilities is in place in the event that a licensee is unwilling or unable to complete the decommissioning.

Enhanced Participating Rulemaking or Radiological Criteria for Decommissioning

Commencing in May 1993, a significant effort has been expended to establish radiological criteria for decommissioning. After a series of seven public workshops to elicit informed discussions of the options and approaches for developing criteria, a proposed rule was published August 22, 1994 (FR 43200). The proposed criteria would apply to the decommissioning of all licensed facilities. The intent is to provide a clear and consistent regulatory basis for determining the extent to which lands and structures must be remediated before a site can be considered decommissioned. It is anticipated that having specific criteria in the regulations would result in more efficient and consistent actions related to the numerous and frequently complex site remediation and decommissioning activities anticipated in the future.

Decommissioning is presently allowed on a site-specific basis using the existing guidance as discussed above. Codifying the radiological criteria for decommissioning in the regulations should allow a more effective implementation of policies to protect public health and safety and the environment at decommissioned sites, by more efficient use of regulatory and license resources, consistent application for all types of contamination, and a predictable basis for decommissioning planning. In addition, delays in decommissioning could be eliminated since licensees could proceed with decommissioning without waiting for specific regulatory approval.

The overall conceptual basis for decommissioning, as proposed in this rulemaking, consists of an objective to reduce the residual radioactivity at the site so that it is indistinguishable from the background, a limit on the dose considered acceptable for release of a site with a stipulation that dose be as far below this limit as reasonably achievable (i.e., ALARA), provisions in regulatory guidance for administrative relief from performing sophisticated ALARA analyses for licensees who have little or no site contamination, provisions for restricted termination of a license when physical remediation activities cannot achieve the limit, and enhanced provisions for public participation. The limit for release of a site is 15 mrem/year total effective dose equivalent (TEDE) for residual radioactivity distinguishable from background. If doses from residual radioactivity are less than the TEDE, the license will be terminated and release for unrestricted use following the licensee's demonstration that the residual radioactivity at the site is ALARA.

The goal is to reduce residual radioactivity to levels that will allow unrestricted release of the site. However, in recognition that this may not always be feasible, licenses may be considered for termination where restrictions may be imposed on the use of the site to ensure that public doses are maintained below the 15 mrem/year TEDE limit, provided the licensee:

(1) Can demonstrate that further reductions in residual radioactivity necessary to comply with the 15 mrem/year TEDE limit for unrestricted use are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;
(2) Has made adequate provisions for institutional controls to reduce annual TEDE from residual radioactivity distinguishable from background to the average member of the appropriate critical group to 15 mrem/year TEDE;
(3) Has provided sufficient financial assurance to enable an independent third party to assume and carry out responsibilities for any necessary control and maintenance of the site; and

(4) Has reduced the residual radioactivity at the site so that the TEDE from residual radioactivity would not exceed 100 mrem/per year even if the restrictions applied in the termination were no longer effective in limiting the possible scenarios or pathways of exposure.

It is important for the public to not only be fully-informed of the decommissioning actions at a particular site but also to be able to effectively participate in site decommissioning decisions. The proposed rule will provide for public participation in the decommissioning process through three mechanisms in addition to the relevant requirements regarding hearing opportunities for a particular site. Upon the receipt of a decommissioning plan from the licensee or a proposal for restricted release of a site, the following actions will occur:

(1) Notify and solicit comments from local and state governments in the vicinity of the site and Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning;
(2) Publish a notice in the Federal Register as well as in other media, such as local newspapers which are readily accessible to individual in the vicinity of the site; and
(3) Solicit public comment on the proposed decommissioning action. These provisions are designed to provide affected individuals and organizations with both information about the proposed decommissioning and an opportunity to provide comments on the licensee's proposal. The Commission believes it is particularly important to provide notice in a forum that is accessible to local individuals. This forum may vary from site to site but would usually include providing notice to local media for publication.

With publication of the proposed rulemaking in August 1994, significant public comments were received. Comments argued for both higher and lower dose limits, more and less sophisticated ALARA analysis, and more and less guidance on surveys, surveying techniques and mathematical data analysis. Consideration of the comments and resolution continues.

Pennsylvania Contaminated Site I

Schott Glass Technologies in Duryea, PA, is a site on the SDMP due to an onsite landfill containing relatively small, discrete volumes of thoriated glass chips and refractory material. Waste glass and materials from manufacturing of glass, including the thoriated glass, were placed in a landfill on the licensee's property from 1969 until 1980. Schott Glass proposes to keep the thoriated glass in the landfill, undisturbed. This will reduce exposure of radiation workers to radiation and lead, a hazardous material in the refractory and minimize air cleaning issues with disturbing a land area. The landfill contains 15,000 cubic feet of scrap, with 8000 lbs. of thoriated glass at a concentration of 17%. This translates into 1400 lbs of source material, or 30 cubic feet.

Since the property will remain under the control of Schott Glass, release for restricted use is appropriate. Schott Glass will cap the existing landfill with a multi-layered cap and erosion control plan consisting of a high density polyethylene (HDPE) textured synthetic liner, HDPE composite drainage net, granular drainage layer, and either a vegetative soil layer or asphalt layer.

These added layers will eliminate any airborne contamination, reduce the external dose to levels indistinguishable from background, provide long-term erosion control, and reduce the likelihood of future excavation in the area of the landfill.

Nonetheless, an ALARA analysis was done. This analysis assumed that an individual would excavate the landfill, select a piece of thoriated glass over refractory or other scrap, fashions a 50 carat pendant by grinding, wears the pendant, and displays the thoriated glass in a display jar at home. The resulting dose for this scenario is approximately 100 mrem/year.

Pennsylvania Contaminated Site II

At the Babcock & Wilcox facility in Leechburg, PA, operations continue to decontaminate several buildings used by the reactor test staff. Procedures have been generated to assure appropriate air sampling. Air contaminant sampling is necessary in order to determine the extent of worker exposure, to determine the effectiveness of air contaminant controls, and to determine regulatory compliance.

Prior to performing air monitoring, a survey of the operation to be monitored should be made. This survey should include:

(1) A review of specific operational activities;
(2) A review of the materials used in the operation;
(3) Identification of employee tasks associated with the operation; and
(4) Review of the results of all previous monitoring for the operation.

In certain instances, it may be desirable to obtain and analyze grab samples by use of direct reading meters or instantaneous reading methods. The resulting information will be used to determine the duration of each sampling period and the number of samples required to obtain results that are representative of the normal work conditions for the operation. The sampling methodology should identify the sampling equipment, sample media, flow rate, and the total sample volume needed for proper sample collection. It is recommended that, prior to any sampling, the analytical laboratory be contacted in order to discuss any special requirements or limitations which may affect sampling methodology.

Prior to performing air sampling, all air sampling pumps must be charged and checked for proper operation prior to use. All air sampling pumps must be calibrated against a primary standard to the specific flow rate identified in the sampling methodology. As an alternate, the pumps may be calibrated against calibration equipment which is periodically checked against a primary standard.

If direct reading meters or instantaneous colorimetric detector tubes are used, follow the manufacturer's directions for equipment preparation and calibration.

Once sample pumps have been adequately charged and properly calibrated, proceed to the selected sample location and perform the following:

(1) Record employee identification and job description;
(2) Place the sampling pump on the employee's belt and attach the sampling media to the employee's shirt collar (or similar position) so that it is within the employee's breathing zone (within a 6 to 9 inch radius of the nose). If measuring welders, place the media under the welder's helmet;
(3) If sampling cassettes are used, ensure that they are in a vertical position with the inlet port of the cassette facing toward the employee's feet. Remove the cap from the inlet port of the cassette;
(4) Turn on the sample pump and note the start time;
(5) Instruct the employee to perform his duties in a normal fashion;
(6) Observe employee activities and operation periodically, (at least every 2 hours) and record any significant observations.

It may also be advisable to record weather conditions and, if possible, obtain photographs of typical sample pump locations.

Procedures such as these have proven to be adequate for obtaining representative samples and assessing the hazard under which decontamination operations are performed.

Massachusetts Contaminated Site

Nuclear Metals, Inc. has manufactured products from depleted uranium for various purposes since 1988. Located in Concord, MA, the major source of uranium contamination at the site was the discharge of neutralized pickling liquor containing copper and depleted uranium to an on-site holding basin between 1958 and 1985. Discharges to the holding basin ceased in 1985, and the basin has been covered with a synthetic cover to minimize evaporation, prevent additional water (rain and snow) from adding to the basin, and to eliminate the potential for any airborne concerns. A decommissioning plan has been prepared that includes removal of the basin sludge and shipment offsite in "superpoly" bags for disposal. Airborne sampling similar to that described above will be conducted during operation for worker's protection and environmental impact.

Two recent incidents have occurred that involved air cleaning issues. The first was a fire in a ventilation system, and the second was a broken buried pipe.

In February 1996, an unplanned/unexpected vent fire occurred within a torrit filter plenum housing and downstream prefilters assembly servicing a pulsed - combustion wastewater evaporation system. The thermocouple systems for the ventilation, installed to detect temperature inconsistencies, was reading low. After replacement of lead wires, troubleshooting, and startup testing, the system was approved for restart. Nonetheless, less than two hours after restart, a fire was observed coming out of the filter cartridges, and a maximum temperature of 750°F observed. Both water and carbon dioxide were used to extinguish the fire. The root cause of the fire was determined to be a thermocouple with reversed wires (polarity).

Damage was obvious. The cardboard framed pipefilters had been completely burned. The high temperature HEPA filters were substantially intact. Upon removal, they were physically dropped to the floor below, resulting in handling damage. Further analysis indicated three of the

four HEPA filters were in good condition, with the fourth having suffered some heat damage, blinding the media rather than opening voids. The media had physically pulled away from one side of the frame, believed to be the result of dropping the filters on the floor.

A total of eight individuals were identified as potentially exposed; five were Emergency Response Team members involved in control and extinguishing of the vent fire, the remaining three acted in support positions, and were never very close to (or actively fighting) the fire itself. All personnel responding to the fire wore SCBA respiratory protective equipment, but were not monitored with any kind of breathing zone air sampler. Because the building was evacuated during response activities, and the HEPA exhaust filtration systems(s) were not compromised, there was no potential for outside/offsite exposures. Urine bioassay samples have been collected from all personnel identified as potentially exposed to any airborne activity, or involved in immediate response to the incident. No indication of uptake to any individual was noted. All potentially affected personnel were equipped with routine external dosimetry devices (film badges).

Air samples of four general types were collected and counted:

(1) In-plant portable "hi-vol" samples (high flow rate, short duration 'grab' samples); taken during the incident, and preparatory to return to service;
(2) In-plant stationary (fixed, continuous, low flow rate); routine workplace air monitoring samples;
(3) Effluent (continuous, low volume); and three exhaust ventilation stacks servicing other areas;
(4) Ambient/environmental (continuous, high volume); a total of eight samplers, two of which can be used as "backgrounds" for evaluation of local/closer stations.

Results of these analyses show no significant or unusual potential for exposure to any individuals (on or off-site) other than those eight persons already identified. Analyses (in-house counting using an automated gas-flow proportional counter) of samples from the eight environmental air stations yielded effective average ambient air alpha activity concentrations ranging from 4.9×10^{-15} to 3.1×10^{-15} μCi/ml; this value is well within the analytical uncertainty of the measurement process, and the normal distribution of values observed in past datasets. It is apparent from these data that any potential exposure to the environment, public, or outside personnel arising from this incident is not significant with respect to routine facility operating emissions, and all applicable effluent regulatory statutes and standards.

During excavation to improve building drainage in May 1996, a wastewater transfer line was broken. This resulted in a leak of approximately 1800 gallons of water containing 380 grams of depleted uranium, a concentration of 20 picocuries/milliliter. The spill was contained onsite, and there were no offsite releases or effects. Contaminated soil was removed. The workers did not use respiratory protection equipment, but breathing zone air samples were employed. Workers with samplers included the maintenance staff who removed the soil, repaired the broken pipe, transferred the soil to bulk bags, provided shoring for the hole, and the backhoe operator. Results indicated minimal worker exposure; the highest DAC-hr (derived air concentration-hour) was less than 0.75.

In addition, two hi-vol grab samples were taken. For ten-minute intervals, the count was equivalent to the minimum detectable activity (MDA) of 4.5×10^{-13} microcuries/milliliters. Similar results were obtained with 30-second counts and an MDA of 2×10^{-13} μCi/ml.

Conclusion

A significant challenge for the nuclear community lies ahead in being able to successfully decontaminate and decommission contaminated structures and environment. Criteria must be clear, concise, fully-understood and achievable. A successful program for decommissioning has the following objectives:

(1) Safety and Timeliness - Ensure timely and safe decommissioning of licensed and unlicensed sites that are contaminated with radioactive materials associated with the possession and use of source, special nuclear, and byproduct materials;
(2) Documentation - Ensure that decommissioning decisions are thoroughly documented to develop a record that will withstand the test of time and avoid transferring a burden to future generations to redevelop information on the radiological status of formerly licensed sites;
(3) Coordination - Coordinate decommissioning actions with regulatory agencies at the federal, state and local levels, with interested parties, and with members of the public to promote efficiency and finality for decommissioning actions;
(4) Minimal Burden - Minimize the burden imposed on licensees and other responsible parties consistent with accomplishing the other objectives; and
(5) Review Capabilities - Develop and maintain review capabilities, as required, to fulfill the objectives of the decommissioning program.

It is expected and anticipated to be able to release sites so that members of the public will have unrestricted access to areas where radioactive materials were once used.

DISCUSSION

FIRST: The acceptable numbers that you gave us with regard to residual contamination, would the NRC consider them to be de minimus exposures? I know the word de minimus gets a lot of peoples' hackles up, but still, you are proposing what I would interpret in that context. Would you comment on that?

BELLAMY: I am glad to. The Nuclear Regulatory Commission tried, about four or five years ago, to define a term which we called, and I have to say this very quietly, "below regulatory concern". That is not a term that we are allowed to use anymore. But to answer your question very specifically, the answer is, yes. This was our attempt to try to define a de minimus-type level, to define a below regulatory concern value without using it as a number.

PORCO: A couple of general questions on the fire, were the prefilters, the Torrit prefilters, cellulose or glass?

BELLAMY: They were glass.

PORCO: Were the HEPA filters commercial grade or were they in accordance with the accepted nuclear standard?

PORCO: Did anyone check on the type of binder that was used? It seems to me that they burned more vigorously than you would expect. Was this an issue?

BELLAMY: It was not an issue. You asked whether anybody checked and the answer is I don't know. I did not check, and I can't answer your question, I believe it may be in the Licensee Event Report that they submitted and I can get you and anybody else a copy if it is of interest.

WEIDLER: You talked about some small scale projects, are there any large-scale projects going on in Region 1 right now? And if so, do the same criteria apply to power plants.

BELLAMY: The answer is, yes. Region 1, in the northeast part of the country, seems to have more than its share of these activities. Of the forty-seven STMP sites that are presently on the list, twenty are in my region, and I have project management responsibility for eleven of them. Nine are managed out of headquarters, but it is still my responsibility to inspect them and make sure that the criteria are met. I believe you are referring to the decommissioning of nuclear power plants and I can assure you that the Shoreham facility did use the criteria. Shoreham has been officially decommissioned and is basically done. The activities at Yankee Rowe are still ongoing and the criteria we are trying to use for decommissioning tend to resist coming up with definitive criteria in the beginning. They would prefer to negotiate the process as it goes along. We have had a challenging time working with them and trying to agree on what would be the objective endpoints. The answer to your question is, yes, there are a number in Region 1.

DAUBER: Were the criteria for determining what would be the worst case determined by the facility owner, by NRC, or by whom?

BELLAMY: The criteria were generated by the Nuclear Regulatory Commission staff in Region 1. The responsible project manager and I, plus our headquarters staff (who give us the project and the program management guidelines) said, what is the worst-case scenario we can come up with that is somewhat realistic? I know that is a contradiction in terms, but that is what we headed for. So it was a Nuclear

Regulatory Commission, an agency-generated scenario. I am not sure what area of the Aberdeen Proving Grounds you are from, but I should mention that Aberdeen is one of the sites on the decommissioning management plan that will be successfully removed from the list in the near future and we expect to renew their license after a public meeting that we will have to have down there. Please attend and be my supporter in the audience. So, congratulations to Aberdeen.

ANON: You talked about Shoreham as one of the utilities that was scheduled for decommissioning, did they meet your original time line? Second, are you aware of a user group, or any issues group, that has been established to effect the decommissioning of public utilities?

BELLAMY: The answer to your first question is, no. There was no success whatsoever in meeting the time lines for any of these activities by nuclear power stations. I am not aware of any utility user group. I know that there is an inter-agency task force that Ken Duvall is a member of, that is generating many decommissioning criteria, but I don't believe there are any utility activities in this area.

FIRST: Last Conference we went out to West Valley, do you have any comments on the clean-up of that facility?

BELLAMY: We are looking at West Valley as a fuel facility, it is in our fuel facility category. I would say we are not so much concerned about the clean-up of that facility as using it for the manufacture of the waste that will be generated from the clean-up of other facilities. I am not involved in West Valley day-to-day, but I understand that we are getting closer and closer to commercial operation at that facility, although we are not there yet.

ENGELMANN: Can you tell us something about the relative authority, the interrelationship of communications between EPA, NRC, and other federal agencies with regard to release criteria?

BELLAMY: As I indicated, there is an interagency task force that is looking on these activities as we speak. If you look at the preprint of my paper, you will note that there is a very long discussion on rule making. We have an enhanced participatory rule-making process which states that members of the public are welcome and expected to participate as we go along in the process, i.e., the term is "enhanced". The proposal is to take the numerical criteria that I have just gone over, and replace them with a criterion that simply says "fifteen millirem per year to any member of the public", period. The Environmental Protection Agency has separate criteria that are in the same ballpark but they are not exactly the same. There are some high level discussions going on at the cabinet level and at the Commission level to try to work out these differences with the Environmental Protection Agency. At the staff level, we work very closely with the Environmental Protection Agency and the Department of Energy on these sites. We will review any EPA documents that are generated. They take our comments very seriously, they welcome our comments, and we are working hand-in-glove with them at the staff level on a number of sites. The particular one that I can think of is the Metcoa-Pesses site near Pittsburgh, Pennsylvania.