UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 2, 2000

Laser Options, Inc.
ATTN: Ms. Beth Millikin
1870 W. Prince, Suite 11
Tucson, AZ 85740

SUBJECT: SUBMISSION OF PAPERS FOR WM'00

Dear Ms. Millikin:

Enclosed please find one original and three copies of the following papers:

1. "Update of NRC's Efforts to Develop Guidance for Decommissioning" by Dominick A. Orlando, et al. (Abstract No. 366,Paper 4, Session 68);

2. "Status of the NRC Decommissioning Program" by Larry Camper and Larry Bell (Abstract No. 345, Paper 1, Session 68); and,

3. Criticality Safety Limits and Regulation of SNM in LLW-a Case Study of the Envirocare Order" by Timothy Harris (Abstract No. 573, Paper 2, Session 22).

I have also included short biographical sketches for Mr. Orlando and Mr. Harris, and the completed submission forms for each paper. Please note that I am unable to provide Laser Options with the copyright waivers for these papers. The papers were developed as part of the authors' duties as Federal employees, in accordance with the direction and approval of their supervisors at the U.S. Nuclear Regulatory Commission. As such, the papers cannot be copyrighted.

If you have any questions or need any additional information, please contact me at (301) 415-7234.

Sincerely,

Larry Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: 1. Abstract No. 366, Paper 4,
Session 68
2. Abstract No. 345, Paper 1,
Session 68
3. Abstract No. 573, Paper 2,
Session 22

Abs. # 366

_WM2K CONFERENCE

SPEAKER FACT SHEET

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What Audio Visual Aids will you use? X **Slides** _____ **Viewgraphs**
LCD Projectors (computer aided) _____
Computer Projectors are limited. Please call to reserve.

ATTACHMENT 1

Biography

Dominick A. Orlando

Mr. Orlando's experience in the field of radiation safety and radioactive and chemical waste management spans 15 years and includes work in research, private consulting and service with the Federal government. Currently, he is a Project Manager in NRC's Office of Nuclear Material Safety and Safeguards where his principal responsibilities include development and coordination of NRC's regulatory policies and positions on mixed waste and Superfund issues, source material issues, and the development guidance for decommissioning and radioactive waste management. In addition, he is the project manager for the decommissioning of several materials, fuel cycle, and non-power reactor facilities. He earned a Bachelors of Science degree from St. Mary's College of Maryland in 1979. He currently lives in Catonsville, MD. with his wife and two daughters.

Update of NRC's Efforts to Develop Guidance for Decommissioning

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ABSTRACT

On July 21, 1997, the U.S. Nuclear Regulatory Commission (NRC) published the final rule on Radiological Criteria for License Termination (the License Termination Rule) as Subpart E to 10 CFR Part 20. NRC regulations require that materials licensees submit Decommissioning Plans to support the decommissioning of its facility if it is required by license condition, or if the procedures and activities necessary to carry out the decommissioning have not been approved by NRC and these procedures could increase the potential health and safety impacts to the workers or the public. NRC regulations also require that reactor licensees submit Post-shutdown Decommissioning Activities Reports and License Termination Plans to support the decommissioning of nuclear power facilities. The NRC staff is currently developing guidance, including a Standard Review Plan, (SRP) and the DandD Screen software for use by NRC in reviewing and evaluating plans and information submitted by licensees to support the decommissioning of nuclear facilities. This paper provides an update of the current status of the NRC staff's efforts to develop this guidance.

INTRODUCTION

U.S. Nuclear Regulatory Commission (NRC) regulations at 10 CFR Parts 30, 40, 70, and 72 require that a decommissioning plan be submitted by a licensee to support the decommissioning of its facility when it is required by license condition, or if the procedures and activities necessary to carry out the decommissioning have not been approved by NRC and these procedures could increase the potential health and safety impacts to the workers or the public. The objective of the decommissioning plan is to describe the activities and procedures that the licensee intends to undertake to remove residual radioactive material at the facility to levels that meet NRC criteria for release of the site and termination of the radioactive materials license. NRC regulations at 10 CFR Part 50 require that, prior to or within 2 years following permanent cessation of operations, licensees must provide NRC with a post-shutdown decommissioning activities report (PSDAR). The purpose of the PSDAR is to provide NRC and the public with a general overview of the proposed decommissioning activities. 10 CFR Part 50 also requires that nuclear power reactor licensees submit a License Termination Plan (LTP) at least 2 years before termination of the license. The purpose of the LTP is to describe the radiological condition of the site, provide a dose assessment for the site, identify the remaining decommissioning activities, and provide the final survey plan for the site. NRC regulations at 10 CFR Part 20, Subpart E describe the criteria for the release of sites for unrestricted and restricted use and is applicable to all NRC licensees.

The NRC staff is currently developing guidance, including a Standard Review Plan (SRP) and the DandD Screen software for use by NRC in reviewing and evaluating plans and information submitted by licensees to support the decommissioning of nuclear facilities. This guidance will

be used by NRC staff and all NRC licensees decommissioning their facilities to determine if the decommissioning can be accomplished safely and if site meets the NRC's requirements for license termination.

The SRP will enable NRC staff to evaluate information submitted by licensees in a timely, efficient and consistent manner, to determine if the decommissioning can be conducted such that the public health and safety is protected and the facility can be released in accordance with NRC's requirements. The SRP will provide NRC staff with a description of the contents of specific decommissioning plan modules, as well as evaluation and acceptance criteria for use in reviewing decommissioning plans and other information submitted by licensees to demonstrate that their facility is suitable for release in accordance with NRC requirements. The SRP will also be used by the NRC staff to evaluate the information contained in the LTP

The DandD Screen software provides a user-friendly analytical tool to address the technical dose criteria contained in NRC's radiological criteria for license termination at 10 CFR Part 20 Subpart E. Specifically, DandD embodies the NRC's screening methodology to allow licensees to convert residual radioactivity contamination levels at their site to annual dose, in a way consistent with both 10 CFR Part 20 and the corresponding implementation guidance described above.

In August 1998, NRC published Draft Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination," (1) for interim use and comment. It addressed the release from regulatory control of buildings and soil and described methodologies that may be used by licensees and others to comply with the License Termination Rule requirements in 10 CFR Part 20, Subpart E. In late 1999, NRC staff, in recognition that similar guidance was being presented in the SRP, decided to combine the guidance in DG-4006 with the guidance in the SRP and use the SRP as the primary guidance document. As such the staff does not plan to publish a final version of the Regulatory Guide. Comments submitted by interested individuals on DG-4006 will be considered as the staff finalizes the SRP.

Although the focus of this paper is the decommissioning of NRC materials licenses, the guidance developed by NRC staff in the SRP will be used to evaluate the applicable portions of decommissioning plans, PSDARs and LTPs. In addition, the DandD Screen software may be used by all NRC licensees to demonstrate that their facility is suitable for release and license termination. This guidance will also be used by NRC staff to evaluate the information submitted by NRC licensees to support the decommissioning of their facilities.

BACKGROUND

On June 27, 1988, NRC amended its regulations at 10 CFR Parts 30, 40, 50, 70, and 72 to set forth the technical and financial criteria for decommissioning licensed nuclear facilities. Since 1988, NRC has further amended its regulations to establish additional record keeping requirements for decommissioning, to establish time frames and schedules for the decommissioning of licensed nuclear facilities, to clarify that financial assurance requirements

must be in place during operations and updated when licensed operations cease, and to establish radiological criteria for license termination. The intent of the regulations is to ensure that the decommissioning of all facilities utilizing source, special nuclear, and byproduct material will be accomplished in a safe and timely manner and that licensees, or responsible parties, will provide adequate funds to cover all costs associated with decommissioning.

NRC regulations require that a decommissioning plan be submitted by a licensee to support the decommissioning of its facility when it is required by license condition, or if the procedures and activities necessary to carry out the decommissioning have not been approved by NRC and these procedures could increase the potential health and safety impacts to the workers or the public. The regulations also require that decommissioning plans contain a description of the planned decommissioning activities, a description of the methods used to ensure protection of workers and the environment against radiation hazards during decommissioning, the choice of the alternative for decommissioning, a description of the controls and limits on procedures and equipment to protect occupational and public health and safety, and a description of technical specifications and quality assurance provisions in place during decommissioning. The objective of the decommissioning plan is to describe the activities and procedures that the licensee intends to undertake to remove residual radioactive material at the facility to levels that meet NRC criteria for release of the site and termination of the radioactive materials license.

Recently, NRC staff has developed guidance for use by the staff and licensees in preparing decommissioning plans including:

- NUREG/BR-0241- NMSS Handbook for Decommissioning Fuel Cycle and Materials Licensees, March 1997 (2). This handbook was developed to facilitate the timely decommissioning of licensed nuclear facilities in a manner that was consistent throughout the NRC, as well as in accordance with all applicable regulatory requirements. It is intended to be used as a reference document to, and in conjunction with, NRC Inspection Manual Chapter (IMC) 2602 "Decommissioning Inspection Program for Fuel Cycle and Materials Licensees." The Handbook is used by NRC staff overseeing the decommissioning program at licensed fuel cycle and materials sites; formerly licensed sites for which the licenses were previously terminated; sites involving source, special nuclear or byproduct material subject to NRC regulation for which a license was never issued; and sites in the NRC's SDMP program. It is not used by NRC staff overseeing the decommissioning program at nuclear reactor facilities subject to regulation under 10 CFR Part 50. Rather, NRC staff overseeing the decommissioning of nuclear reactor facilities use the procedures described in the Decommissioning Project Manager's Handbook. NRC staff implementing the decommissioning program at uranium recovery facilities use the guidance in IMC 2801 "11e.(2) Byproduct Material Disposal Site;

- NUREG-1575 - The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), December 1997 (3). MARSSIM is a consensus document developed collaboratively by the Department of Defense, the Department of Energy; the Environmental Protection Agency and the Nuclear Regulatory Commission, each of

which have authority over radioactive materials. It provides detailed guidance for planning , implementing and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose or risk -based regulation. MARSSIM does not provide guidance for translating the applicable release criterion into derived concentration limits. MARSSIM addresses surveys for contamination in surface soil and on building surfaces. Other media, such as ground or surface water, subsurface soil and vicinity properties are not directly addressed in the MARSSIM;

- NUREG-1505 - A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys, June 1998 (4). NUREG-1505 describes a nonparametric statistical methodology for the design and analysis of final status decommissioning surveys in support of the License Termination Rule. The techniques described are expected to be applicable to a broad range of circumstances, but do not preclude the use of alternative methods as particular situations may warrant. Nonparametric statistical methods for testing compliance with decommissioning criteria are provided both for the case in which the radionuclides of concern occur in background and also for the case in which they do not occur in background. The tests described are the Sign test, the Wilcoxon Rank Sum test, and a Quantile test. These tests are performed in conjunction with an Elevated Measurement Comparison to provide confidence that the radiological criteria specified for license termination are met. The Data Quality Objectives process is used for the planning of final site surveys. This includes methods for determining the number of samples needed to obtain statistically valid comparisons with decommissioning criteria and the methods for conducting the statistical tests with the resulting sample data;

- NUREG-1507 - Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, June 1998 (5). NUREG-1507 describes and quantitatively evaluates the effects of various factors on the detection sensitivity of commercially available portable field instruments being used to conduct radiological surveys in support of decommissioning. An important factor affecting the costs and quality of such radiological surveys is the minimum detectable concentration (MDC) of field survey instruments in relation to the residual contamination criteria. This report evaluates the MDC for various field survey instruments and provides guidance for: (a) selection and proper use of portable survey instruments; and (b) understanding the field conditions and the extent to which the capabilities of those instruments can be limited. The types of instruments commonly used in field radiological surveys that were evaluated include, in part, gas proportional, Geiger-Muller, zinc sulfide and sodium iodide detectors; and,

- DRAFT NUREG-1549 - Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination July 1998 (6)(published for interim use and comment). NUREG-1549 describes an overall framework for dose assessment and decision making at sites where licensees have decided to begin the decommissioning and license termination process. The framework is designed to assist the licensee, NRC and stakeholders in making decommissioning decisions. By doing so it allows the licensee to

coordinate its planning efforts with the NRC's input, to conduct dose assessments and site characterization activities remediation and land-use restrictions, to integrate analyses' for ALARA requirements and to elicit other stakeholder input at crucial points in the decommissioning process. The framework also provides an approach for treating some of the uncertainty associated with contaminated sites.

CURRENT EFFORTS

On July 21, 1997, NRC published the final rule on Radiological Criteria for License Termination (the License Termination Rule) as Subpart E to 10 CFR Part 20 (7). Under Subpart E, licensees must demonstrate its site is suitable for release in accordance with the criteria in Subpart E. Subpart E establishes criteria for the release of sites for unrestricted use, if the residual radioactivity that is distinguishable from background results in a total effective dose equivalent to an average member of a critical group that does not exceed 0.25 millisievert (25 millirem) per year and the residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA). Subpart E also establishes criteria for license termination under restricted use conditions if specific conditions are met and in unusual situations NRC may release sites exceeding the 0.25 millisievert limit if certain specified criteria are met. NRC staff is currently developing additional guidance to assist licensees and NRC staff in evaluating decommissioning plans and other information submitted by licensees to support license termination.

On July 8, 1998, the Commission approved the publication of the draft guidance for the License Termination Rule for a 2-year interim use period and instructed the NRC staff to maintain a dialogue with the public through the use of a Website and public workshops. The Commission also directed the NRC staff to develop a Standard Review Plan (SRP) that incorporates the risk-informed, iterative approach in NUREG-1549, including providing clear guidance on complying with the ALARA provisions in the final License Termination Rule. In addition, the Commission directed the NRC staff to review the potential conservatism in the DandD Screen software, test the DandD code on a complex decommissioning site, and use it as the pilot for developing the SRP. The NRC staff's efforts in developing this guidance are summarized below.

DG-4006

This document superceded a working draft of the RegGuide, which was published in August 1994 as NUREG-1500. DG-4006 addressed the release from regulatory control of buildings and soil but did not pertain to the release of contaminated equipment. It described methodologies that may be used by licensees and others to comply with the License Termination Rule. These regulatory positions are:

- Dose Modeling - Provides methods acceptable to NRC for demonstrating compliance with the dose criteria in the License Termination Rule. In particular, it addresses dose modeling methods to relate concentrations of residual radioactivity to dose to the average member of the critical group in order to demonstrate the dose criterion in the License Termination Rule have been met. It references NUREG -1549, which provides an acceptable methodology for calculating doses.

- Methods for Conducting Final Status Surveys - Provides guidance on methods acceptable to NRC for conducting final radiation surveys for buildings and soil prior to terminating the license. It references the MARSSIM, NUREG 1505, and NUREG 1507 as acceptable methods for conducting final status surveys.

- ALARA analysis - Provides guidance on methods acceptable to NRC to demonstrate that residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA). It also provides staff positions on acceptable methods to demonstrate that further reductions in residual radioactivity are not technically achievable, could result in net public or environmental harm or are prohibitively expensive. These demonstrations are necessary should a licensee request termination of its license under restricted use conditions.

- License Termination under Restricted Conditions - Provides guidance on methods acceptable to NRC for terminating a license under restricted conditions, including establishing adequate institutional controls, demonstrating adequate financial assurance, and seeking public input on the proposed restrictions

DG-4006 also discussed how these regulatory positions should be integrated during license termination activities. Staff initially intended to finalize the guidance by July 2000. In September 1999, NRC staff stated that it would accept comments on DG-4006 until November 1999. NRC staff received approximately 185 comments on DG-4006 from four professional organizations, one Federal agency, 3 State regulatory agencies and the Conference of Radiation Control Program Directors, and two private concerns.

In late 1999, NRC staff, in recognition that similar guidance was being presented in the SRP, decided to combine the guidance in DG-4006 with the guidance in the SRP and use the SRP as the primary guidance document. As such, the staff does not plan to publish a final version of the Regulatory Guide. Comments submitted by interested individuals on DG-4006 will be considered as the staff finalizes the SRP.

Standard Review Plan

The NRC staff is currently developing an SRP for use by NRC in reviewing and evaluating plans and information submitted by licensees to support the decommissioning of nuclear facilities. When completed, the SRP will enable NRC staff to evaluate information submitted by licensees in a timely, efficient and consistent manner, to determine if the decommissioning can be conducted such that the public health and safety are protected and the facility can be released in accordance with NRC's requirements. The SRP will provide NRC staff with a description of the contents of specific decommissioning plan modules, as well as evaluation and acceptance criteria for use in reviewing decommissioning plans and other information submitted by licensees to demonstrate that their facility is suitable for release in accordance with NRC requirements.

The SRP provides NRC staff with a description of the format and contents of specific decommissioning plan modules, as well as an evaluation and acceptance criteria for use in reviewing decommissioning plans and, other information submitted by licensees to demonstrate that the facility is suitable for release in accordance with NRC requirements. The format of the SRP will follow the format described in NUREG-1200 "Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility"(8). The technical issues and topics addressed in the SRP will be addressed relative to several functional areas summarized above. These functional areas will be further divided into specific technical review areas. Each technical review area will consist of the following sections:

- Responsibility for Review - Identifies the organization(s) responsible for evaluating the subject or technical review area covered by the functional area;
- Areas for Review - Describes the information that will be reviewed by the organization responsible for the review;
- Review Procedures - Describes how the review will be performed including step wise procedures that the reviewer will follow to verify the acceptance criteria have been satisfied;
- Acceptance Criteria - Describes the purpose of the review, the applicable regulatory requirements and related guidance, and the technical bases for determining the acceptability of the licensee's proposed activity;
- Evaluation Findings - Describes the type of conclusion that is required for the technical review area;
- References - Lists the references that will be used in the review process.

The SRP will supersede Regulatory Guide 3.65, "Standard Format and Content of Decommissioning Plans for Licensees under 10 CFR Parts 30, 40, and 70," (9) and Policy and Guidance Directive FC 91-2, "Standard Review Plan: Evaluating Decommissioning Plans for Licensees under Parts 30, 40, and 70"(10). It will also supersede the applicable portions of Inspection Manual Chapter 2605, "Decommissioning Procedures for Fuel Cycle and Materials Licensees," (11) and the NMSS Decommissioning Handbook. As appropriate, the staff will update IMC 2605 and the Decommissioning Handbook to reflect the procedures and criteria in the SRP.

To obtain input from the regulated community on issues that needed to be addressed in the SRP, NRC staff held a series of workshops on dose modeling, surveys, demonstrating ALARA, and restricted use/alternate criteria. Workshops were held on December 1-2, 1998; January 21-22, 1999; March 18-19, 1999; June 16-17, 1999; August 18-19, 1999 and February 17-18, 2000. An additional workshop will be held in June 2000 to discuss specific technical issues associated with dose modeling. In addition, as draft SRP modules were completed, they were posted on the NRC Website at: http//www.nrc.gov.for review and comment by interested individuals.

DandD Screening Model

The DandD Screen software provides a user-friendly, generally automated interface to NRC's dose assessment and screening methodology for site assessment against the Radiological Criteria for License Termination Rule in 10 CFR Part 20 Subpart E. DandD Screen assists NRC licensees who have requested termination of their license and who, in some cases, must decontaminate lands and structures as part of the decommissioning process by allowing licensees to translate residual radioactive contamination levels at their site into total effective dose equivalent (TEDE) by analyzing and modeling the set of NRC-prescribed scenarios of future land-use. DandD contains models of the transport and exposure pathways associated with each of the scenarios, requiring only information on source concentration from the user. Using DandD, and within the context of the decision methodology described in draft NUREG-1549, the user may supply site-specific parameter values if available and defensible, may modify or eliminate pathways, and may propose alternative critical groups and/or scenarios.

Specifically, DandD Screen is the software implementation of NRC's screening methodology transport and exposure models for assessing human health and safety against the dose requirements set forth in 10 CFR Part 20 Subpart E. For this discussion, screening refers to the release of a site where little or no site-specific information is known or used, other than level of contamination. To provide useful and defensible screening level calculations, the NRC has developed reasonably conservative scenarios, pathway models, and parameter values, and has implemented these in DandD Screen. "Reasonably conservative" implies that the calculated doses are much more likely to be overestimates of the actual dose rather than accurate estimates or underestimates, but at the same time are not necessarily worst case estimates. As a result, the scenarios and models implemented in DandD Screen are relatively simple. To perform these screening calculations, the DandD Screen software automates the scenarios, models, mathematical formulations, and assumptions documented in NUREG/CR-5512, Volume 1 (12) with a few corrections and enhancements. The generic modeling approach defines radiation exposure scenarios to address residual radioactive contamination inside buildings, in soils and in ground water. For buildings, two scenarios are presented. These scenarios relate both volume and surface contamination levels to estimates of the annual TEDE received during a year of exposure with the conditions defined in the scenarios.

For the simplest level of analysis (previously referred to as Level 1 screening), the user is required to provide a minimum amount of site-specific information. In general, only information about contaminant concentration is required for this level of analysis. This level of analysis is automated in DandD Screen, and therefore provides certain licensees a simple and cost-effective method for demonstrating compliance using a minimum amount of information. This level of analysis implements the generic scenarios and models from NUREG/CR-5512, Volume 1, (13) and uses deterministic values for all model parameters that have also been defined to be reasonably conservative. The default parameter values in DandD Screen Version 1.0 have been defined through a systematic process of assessing the variability of each parameter across the U.S. and then defining default values that produce generic dose estimates that are unlikely to be

exceeded at any real site. In summary, the default models and parameter values are intended to estimate the upper range of the dose that the average member of the critical group could receive at any site given the contaminant level at that site.

If a licensee has site-specific information for certain parameters, they may choose to replace the default parameter values with alternative values, and employ the default transport and exposure models. This level of analysis (previously referred to as Level 2 screening) is easily conducted with DandD Screen. Licensees are not required to conduct the "Level 1" screening calculations prior to proposing changes to parameter values if they have such information to do so.

The default parameter values for the NUREG/CR-5512 modeling (which are implemented in DandD Screen) are based on probability distributions representing the variability across the country. As a consequence, the licensee would likely need little supporting information to defend significant changes to the physical parameter values. For example, the probability distributions used in defining the default values for radionuclide sorption in soils for the NUREG/CR-5512 residential scenario models is based on the variety of all possible soil types and geochemical conditions. In order to provide a defensible screening process where a license could be terminated based only on residual contamination data, the parameter analysis produces default values for some of the sorption coefficients that are representative of the lower measured values. Therefore, many sites would be able to defend a significantly higher sorption coefficient and input this value into DandD Screen. This approach of moving away from the "reasonably conservative" values used in the NUREG/CR-5512 modeling could be used by all sites until the point that further reduction in simulated dose would require model changes. This would necessarily require the licensee to step away from using DandD Screen. At that point, new model parameter values would have to be developed and defended by the licensee. Model changes should lead to less conservative models and lower doses with each iteration, because the NUREG/CR-5512 models are designed to be inherently conservative.

DandD Screen is intended to be implemented within the structure of NRC's decommissioning decision framework documented in draft NUREG-1549. This process has been defined to allow licensees to define the most cost-effective decommissioning and license termination strategy by evaluating alternative actions at their site, including possible reductions in uncertainty that would reduce overall remediation costs. As such, because of nature of the DandD Screen models and default parameter values, the NRC does not expect licensees to define concentration clean-up levels based on preliminary DandD Screen dose calculations that fail to meet 10 CFR Part 20 dose criteria; rather, licensees are encouraged to evaluate the cost of added information and the value it adds in better defining remedial actions.

The results of the modeling in DandD Screen are used to produce reports, in NRC-defined and accepted text and graphics formats, that will allow the NRC to efficiently assess compliance with the 10 CFR Part 20 dose criteria and to determine if more detailed modeling should be required.

NRC staff will be assisted in the development of the guidance by several contractors over the two-year period. Sandia National Laboratory (SNL) will refine and complete the decision framework documented in NUREG-1549. NUREG-1549 provides guidance on conducting dose

assessments to demonstrate compliance with Subpart E of 10 CFR Part 20. It is expected that the SRP on dose modeling will build on NUREG-1549. Work will include testing the decision framework described in NUREG-1549 on real sites. Testing the framework will help to resolve key issues on implementing the framework. In addition, SNL will be developing a specific approach for defensibly moving away from using the generic land-use scenarios (i.e., building occupancy and resident farmer) identified in NUREG-1549. SNL will continue technical and user support for the DandD software, develop a version of DandD that integrates a Monte Carlo shell to support modification of parameter distributions based on site-specific information, publish NUREG/CR-5512 Volumes 2 (User's Manual), 3 (parameter analysis) and 4 (model comparison), and evaluate extensions to DandD to support dose calculations for subsurface contamination.

Argonne National Laboratory will develop parameter distributions, data ranges, and a single default parameter set for the RESRAD and RESRAD-Build computer codes. These two codes are currently widely used in dose assessment analyses. Work will provide information for developing an approach in the SRP for doing site-specific analyses. In addition, this information will be useful to staff in specifically reviewing licensees' dose assessment analyses involving these codes.

Pacific Northwest Laboratory will provide the technical bases, including generic databases and sources of information, and uncertainty assessment methodology for evaluating the parameters and assumptions in the ground-water pathway component of the dose models to be used in site-specific modeling assessments.

In addition to Version 1 of the DandD code described above, staff is developing Version 2 of the DandD Screen which will allow a Monte Carlo analysis of potential doses. Staff is also developing probabalistic distributions for the parameters in the RESRAD dose modeling code.

Staff has also developed, using the DandD Screen code, modified to reduce the inherent conservatism in a few of the default parameters in the code, concentrations of radionuclides on surfaces and in surface soil that may be used by licensees that do not wish to develop these values using the DandD Screen code. These values were published in the in the Federal Register on November 18, 1998 (63 FR 64132) and December 7, 1999 (64 FR 68395), respectively.

CONCLUSION

The NRC staff is currently developing guidance, including a Standard Review Plan and the DandD Screen Model for use by NRC in reviewing and evaluating plans and information submitted by licensees to support the decommissioning of nuclear facilities. To obtain input from the regulated community on issues that will need to be addressed in the guidance, the NRC staff has held workshops on dose modeling, surveys, demonstrating ALARA, and restricted use/alternate criteria. NRC staff currently expects to complete the development of this guidance in mid-2000.

Although the focus of this paper has been the decommissioning of NRC materials licenses, the guidance developed by NRC staff in the SRP will be used to evaluate the applicable portions of decommissioning plans, PSDARs and LTPs. In addition, the DandD Screen software will be used by all NRC licensees to demonstrate that their facility is suitable for release and license termination. This guidance will also be used by NRC staff to evaluate the information submitted by NRC licensees to support the decommissioning of their facilities.

REFERENCES

(1) USNRC, "Demonstrating Compliance with Radiological Criteria for License Termination," Draft Regulatory Guide DG-4006, U.S. Nuclear Regulatory Commission, Washington D.C. August 1998

(2) Orlando, D.A., et al, " NMSS Handbook for Decommissioning Fuel Cycle and Materials Licensees," NUREG/BR-0241, U.S. Nuclear Regulatory Commission, Washington, DC, March 1997.

(3) USNRC, "The Multi-Agency Radiation Survey and Site Investigation Manual," NUREG-1575, U.S. Nuclear Regulatory Commission, Washington, DC December 1997.

(4) Gogolak, C.V., et al, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys," NUREG-1505, U.S. Nuclear Regulatory Commission, Washington, DC June 1998.

(5) Abelquist, E.W., "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," NUREG-1507, U.S. Nuclear Regulatory Commission, Washington, DC June 1998.

(6) USNRC, "Decision Methods for Dose Assessment to Comply with Radiological Criteria for License Termination," NUREG-1549, U.S. Nuclear Regulatory Commission, Washington, DC July 1998

(7) USNRC, 10 CFR 20 ,et al., "Radiological Criteria for License Termination; Final Rule, Federal Register, Vol.62, No. 139, Monday July 21, 1997, pp 39058-39095.

(8) USNRC"Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility" NUREG-1200, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, DC January 1991

(9) USNRC Regulatory Guide 3.65 "Standard Format and Content of Decommissioning Plans for Licensees under 10 CFR Parts 30, 40, and 70," U.S. Nuclear Regulatory Commission, Washington, DC, August 1989

(10) USNRC Policy and Guidance Directive FC-91-2 "Standard Review Plan: Evaluating Decommissioning Plans for Licensees under 10 CFR Parts 30, 40, and 70," U.S. Nuclear Regulatory Commission, Washington, DC, January 1991

(11) USNRC Inspection Manual Chapter 2605, "Decommissioning Procedures for Fuel Cycle and Materials Licensees"

(12) Kennedy, W.E. and D.L. Strenge, "Residual Radioactive Contamination from Decommissioning," NUREG/CR-5512, Volume 1, U.S. Nuclear Regulatory Commission, Washington, DC, October 1992

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What Audio Visual Aids will you use? X **Slides** _____ **Viewgraphs**
LCD Projectors (computer aided) _____
Computer Projectors are limited. Please call to reserve.

ATTACHMENT 2

Biography

Dominick A. Orlando

Mr. Orlando's experience in the field of radiation safety and radioactive and chemical waste management spans 15 years and includes work in research, private consulting and service with the Federal government. Currently, he is a Project Manager in NRC's Office of Nuclear Material Safety and Safeguards where his principal responsibilities include development and coordination of NRC's regulatory policies and positions on mixed waste and Superfund issues, source material issues, and the development guidance for decommissioning and radioactive waste management. In addition, he is the project manager for the decommissioning of several materials, fuel cycle, and non-power reactor facilities. He earned a Bachelors of Science degree from St. Mary's College of Maryland in 1979. He currently lives in Catonsville, MD. with his wife and two daughters.

Status of the NRC Decommissioning Program

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ABSTRACT

This paper provides an update, based on a staff briefing of the Commission in July 1999, on the status of the U.S. Nuclear Regulatory Commission's (NRC's) decommissioning program. It discusses the staff's rebaselining (management reviews of major milestones; staff review schedules; major technical and regulatory issues; etc...) of complex decommissioning cases and of sites listed in the Site Decommissioning Management Plan. The paper will also address the status of permanently shut-down commercial power reactors and touch upon the impacts related to the transfer of complex decommissioning sites and sites listed on the SDMP to Agreement States. The status of NRC's reviews of site decommissioning in accordance with: 1) the NRC's Action Plan Criteria ["grandfathered," pursuant to 10 CFR 20.1401(b)]; and 2) site decommissioning under the NRC's license termination rule criteria published in July 1997, will also be provided. In addition this paper will offer an overview of NRC staff responsibilities related to reactor decommissioning and the measures that the staff has implemented to ensure a seamless exchange of decommissioning responsibilities among the involved NRC organizations.

INTRODUCTION

The major components of the U.S. Nuclear Regulatory Commission's (NRC's) decommissioning program consist of the Site Decommissioning Management Plan (SDMP), complex site decommissioning, and power reactor decommissioning. The major activity undertaken in the Decommissioning Program is to regulate the decontamination and decommissioning of power reactors, non-power reactors, fuel cycle facilities, and material licensees. Decommissioning program activities include: (1) development of regulations and guidance; (2) conduct of research to develop data, techniques, and models used to assess public exposure from the release of radioactive material resulting from site decommissioning; (3) review and approval of decommissioning plans (DPs) and license termination plans (LTPs); (4) review and approval of license amendment requests; (5) inspections of licensed activities; (6) development of environmental assessments (EAs) and environmental impact statements (EISs); (7) review and approval of final site survey reports; and (8) conduct of confirmatory surveys.

The Offices of Nuclear Material Safety and Safeguards (NMSS), Nuclear Reactor Regulation (NRR), and Nuclear Regulatory Research (RES) all have responsibilities for decommissioning program activities. Steps have been taken by the staff to ensure that appropriate levels of integration of decommissioning activities within the Agency take place. These steps include, the tracking decommissioning activities in the Agency Operating Plan; and using management overview of decommissioning activities via the Decommissioning Management Board (Board).

The Board meets bi-weekly and is composed of managers from NMSS, RES, NRR, and the Regions, and serves as an effective mechanism for integrating inter-Office and regional coordination of program activities and issue resolution.

BACKGROUND

NRC staff periodically provides reports on the various facets of the decommissioning program. In the past, the NMSS staff would brief the Commission on the progress of the remediation of the SDMP sites; NRR staff would brief the Commission on power reactors decommissioning issues. In June 1999 and August 1999, the Commission directed the staff to provide a single coordinated annual report on the Agency's decommissioning program. The first coordinated report is scheduled to be forwarded to the Commission in March 2000.

The majority of the sites remaining in the SDMP are all the more complicated decommissioning cases. A number of these sites are anticipated to be released as restricted-use cases and are the most technically complex, and generally require the largest expenditures of staff resources. Site-specific dose assessments, including complex groundwater modeling, will be required. Some these sites may require "durable institutional controls" that, as specified in 10 CFR 20.1403(e), will be implemented on a case-by-case basis. There are 11 sites in Pennsylvania and Minnesota, States with pending applications to become Agreement States. It has not yet been determined whether their planned agreements would include the SDMP and complex sites.

POWER REACTOR DECOMMISSIONING

NMSS and NRR signed a Memorandum of Understanding (MOU) on March 10, 1995, which delineates the transfer of responsibilities for power reactor decommissioning from NRR to NMSS. In accordance with the MOU, NRR will be responsible for regulatory project management, oversight, and inspection support for a reactor undergoing decommissioning until all spent fuel is permanently transferred from the spent fuel pool. After the spent fuel is permanently transferred from the spent fuel pool, NMSS assumes responsibility for project management and oversight.

The MOU gives NMSS responsibility for LTPs, and preparing related safety evaluation reports, environmental assessments and license termination orders or amendments. NMSS is also responsible for confirmatory surveys and license termination activities, including assurance that appropriate site release criteria have been met.

Two power reactors (Shoreham and Ft. Saint Vrain) have been decommissioned and their licenses have been terminated. Currently NRR has regulatory project management responsibility for 16 power reactors. The licensees have submitted Post Shutdown Decommissioning Activities Reports (PSDARs) for these power reactors. The purpose of a PSDAR is to provide the NRC and the public with a general overview of a licensee's proposed decommissioning activities.

Regulatory project management responsibility for two power reactors (Fermi 1 and Peach Bottom Unit 1) has been transferred from NRR to NMSS. NMSS staff is currently reviewing the LTP for Trojan and expects to receive and initiate reviews of LTPs for Saxton, Main Yankee, and Connecticut Yankee in calendar year 2000.

The staff is in the process of developing guidance documents that will provide the staff with uniform criteria for staff reviews of licensee LTP submittals and to help licensees prepare acceptable decommissioning documents.

Decommissioning power reactor's do not pose the same risk to public health and safety as they did during operations. However, under current regulations they are subject to the same requirements. To address this shortcoming in the regulations the staff has proposed the initiation of a rulemaking effort that would address emergency planning, insurance, safeguards, operator staffing and training, and backfit. The proposed regulations would apply to licensees that certified, pursuant to 10 CFR 50.82 (a), that they have permanently ceased facility operations and have permanently removed fuel from the reactor vessel. The proposed regulation would cover the following: (1) emergency planning; (2) insurance; (3) safeguards; (4) operator staffing and training: and (5) backfit. Proposed rulemaking efforts are also ongoing in the area of partial site release.

SDMP AND COMPLEX SITES

The staff created the SDMP at the direction of the Commission. In it's directives to the staff, the Commission, in August 1989 and January 1990, directed the staff to develop a comprehensive strategy for achieving closure of decommissioning issues. Therefore, the major objectives of the SDMP, when initiated were: (1) to identify and manage specific problem sites through the decommissioning process; and (2) to resolve decommissioning policy issues.

The original five criteria use by the staff for placing sites on the SDMP were: (1) problems with the financial viability of responsible parties or organizations; (2) the presence of large volumes of contaminated soil, sludge, or slag, or onsite burials; (3) long-term presence of contamination of unused facility buildings; (4) license previously terminated that exceeded the existing unrestricted release criteria; and (5) contamination or potential contamination of the groundwater from on site waste. The staff initially presented the SDMP to the Commission in SECY-90-121, dated March 29, 1990.

In the context of a comprehensive decommissioning program, the SDMP becomes primarily a management tool to track site-specific progress at complex decommissioning sites. Adding a new site to the SDMP will not necessarily indicate that the site is a "problem" site. Current SDMP listing criteria are as follows: (1) all restricted-use sites; and (2) complex unrestricted-use sites that require: (a) detailed site-specific dose modeling; (b) sites subject to heightened public, State, or Congressional interest; and (c) sites with questionable financial viability.

Sites released from the SDMP to date have been released using the criteria contained in the "Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites" SDMP Action Plan 57FR 13389. (1) In July 1997 the Commission published the License LTR. Draft guidance for demonstrating compliance with the LTR was published in August 1998, in draft Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination." (2) The LTR initially authorized two different sets of cleanup criteria for SDMP sites: (1) SDMP Action Plan criteria; and (2) the dose-based criteria contained in 10 CFR Part 20, Subpart E.

Under the provisions of 10 CFR 20.1401(b), any licensee that submitted its DP before August 20, 1998, and received NRC approval of that DP before August 20, 1999, could use the SDMP Action Plan criteria for site remediation. Because of the advanced status of the reviews at 12 sites, in August 1999, the Commission granted an extension of the DP approval deadline to August 20, 2000, for these sites.

Currently, 26 sites remain in the SDMP, and three sites are classified as complex decommissioning sites (these site have not yet been added to the SDMP). In addition, there are three complex decommissioning sites undergoing decommissioning. Twenty sites have been removed from the SDMP after successful remediation.. Another 14 sites have been removed from the SDMP after transfer to an Agreement State or the U.S. Environmental Protection Agency (EPA).

A preliminary analysis of information related to SDMP and complex sites yields the following: (1) five of 29 SDMP and complex decommissioning sites have not yet submitted DPs; (2) the staff has approved nine of 22 DPs submitted to date; and (3) last site should be removed from the SDMP by 2020 based on assumptions used by the staff during rebaselining. Each site schedule was developed independently, using standard assumptions developed by the staff. Changing the site-specific or standard assumptions may have a significant impact on the site decommissioning schedules.

The site decommissioning schedules are based on the standard assumption that the NRC will retain regulatory responsibility for SDMP and other complex decommissioning sites located in States scheduled to become Agreement States in the near future. However, it is possible that as many as 11 of the current SDMP sites may be transferred to Agreement States (Minnesota-1; Pennsylvania-10).

In addition to its oversight of decommissioning efforts at SDMP and complex decommissioning sites, the decommissioning program is responsible for following and regulating decommissioning activities at contaminated sites identified under the Oak Ridge National Laboratory (ORNL) Terminated License Review Project. As a result of the ORNL review, and subsequent follow-up by the Regions, 37 formerly licensed sites were found to have residual contamination levels exceeding NRC's criteria for unrestricted release. Seventeen of these sites have been closed after successful remediation or transfer to Agreement States. Twenty sites remain open pending remediation. Two of the formerly licensed sites have been added to the SDMP because these sites will require non-routine decommissioning activities. The remaining sites are considered to

be non-complex and therefore do not warrant placement on the SDMP at this time. However, it is possible that these sites may be added to the SDMP if site conditions change.

REBASELINING OF THE DECOMMISSIONING PROGRAM

Because the remaining SDMP and complex sites are expected to require larger staff resources than previously removed sites, the staff has undertaken a rebaselining initiative. The purpose of the rebaselining initiative is to add more efficiency and effectiveness to the decommissioning process. The staff intends to use the rebaselining to establish priorities and schedules for each of the remaining SDMP and complex sites.

The rebaselining initiative commenced in September 1999, with the key activities including the following: (1) update and assess the current status of each SDMP and complex decommissioning site; (2) develop comprehensive integrated plans for addressing major milestones for each SDMP, power reactor license termination plan (LTP), and complex decommissioning site; and (3) develop and implement realistic schedules for each SDMP, power reactor LTP, and complex decommissioning site to either successfully bring the sites to closure, or to establish priorities for effective and efficient use of staff resources.

In addition, as part of the rebaselining process, the staff is seeking efficiency improvements through the following two means: (1) participation in the overall Agency effort to streamline licensing procedures; and (2) continued implementation of the Integrated Licensing and Inspection Program (ILIP). The streamlining licensing process is intended to facilitate staff reviews and licensing decisions in accordance with defined and agreed-upon schedules. The staff developed the ILIP in 1997. The ILIP assures that resources for decommissioning activities are prioritized and that licensing and inspections activities are properly coordinated. The staff believes that staff resources required for decommissioning of SDMP sites and power reactors can be significantly reduced through the streamlining process and ILIP.

CONCLUSIONS

The NRC staff is in the process of finalizing a report, in accordance with Commission direction, on the Agency's decommissioning program. The staff has taken steps to ensure that appropriate levels of integration of decommissioning activities within the agency occur. These steps include: (1) tracking decommissioning activities in the Agency Operating Plan; and (2) using management overview of decommissioning activities via the Decommissioning Management Board.

The staff's rebaselining initiative will establish goals for individual decommissioning cases, to either successfully bring the sites to closure, or to establish priorities for effective and efficient use of staff resources.

REFERENCES

(1) Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites. Federal Register, Vol. 57, Thursday, April 16, 1992.

(2) U.S. Nuclear Regulatory Commission, U.S. Code of Federal Regulations 10 CFR Part 20, et al, "Radiological Criteria for License Termination; Final Rule, Federal , Register Vol.62, No. 139, Monday July 21,1997, pp 39058-39095.

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ATTACHMENT 3

Biography

Timothy E. Harris

Mr. Harris's experience in the field of radioactive waste management and decommissioning of nuclear facility spans 10 years. Mr. Harris currently is a Project Manager in NRC's Office of Nuclear Material Safety and Safeguards where his principal responsibilities include lead for special nuclear material issues in low-level waste, review of dose assessments for the buried radioactive material, and development guidance for decommissioning and radioactive waste management. He earned a Bachelors of Science degree from the University of Maryland in 1983. He currently lives in Fredericksburg, VA with his wife and two children.

Criticality Safety Limits and Regulation of SNM in LLW – a Case Study of the Envirocare Order

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ABSTRACT

The U.S. Nuclear Regulatory Commission issued an Order to Envirocare of Utah, Inc. exempting it from licensing requirements in 10 CFR Part 70, subject to certain conditions, for possession of special nuclear material (SNM) in excess of the mass limits in 10 CFR Part 150. This Order established concentration-based limits for SNM that provide the same level of protection as the current mass limits specified in 10 CFR 150.11. Under these concentration limits and conditions, Envirocare can possess an unlimited quantity of SNM. This presentation discusses the regulatory background of the disposal of SNM low-level waste (LLW), the basis of the Envirocare Order, and possible changes to NRC regulations.

INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) regulates the commercial uses of nuclear material. This paper discusses NRC's regulation of special nuclear material (SNM) and low-level waste (LLW) disposal. It provides a regulatory background and current regulatory framework of SNM and LLW. Unlike other radioactive material, SNM posses a unique concern in that a criticality, a chain reaction where large numbers of neutrons are produced, can result under certain conditions. These conditions and means to prevent criticality are discussed in detail below. This paper also discusses an Order issued to Envirocare of Utah, Inc. (Envirocare) exempting Envirocare from certain NRC regulations relative to the possession and disposal of SNM at its Clive, Utah disposal facility. The safety basis and associated conditions of the Order are discussed. In addition, this paper discusses possible regulatory changes relative to SNM and LLW disposal.

REGULATORY BACKGROUND OF SNM AND LLW DISPOSAL

The Commission's authority to regulate SNM is contained in Chapter 6 (§§ 51 - 58) of the Atomic Energy Act (AEA) of 1954, as amended. The AEA requires persons who possess SNM to have a general or specific license issued by the Commission. Pursuant to Section 274(b) of the AEA, NRC can enter into agreements with States (called Agreement States) where the State assumes the regulatory authority to regulate byproduct, source and SNM. Because of criticality concerns, the quantity of SNM that an Agreement State can regulate is limited. This is codified in 10 CFR Part 150, "Exemptions and Continued Regulatory Authority in Agreement States and in Offshore Waters under Section 274." This section of the regulations provides certain exemptions to persons in Agreement States from certain NRC licensing requirements and defines

activities in Agreement States over which the regulatory authority of the NRC continues. As it relates to SNM, 10 CFR 150.10 exempts persons in Agreement States from NRC licensing for SNM in quantities not sufficient to form a critical mass. Quantities not sufficient to form a critical mass are defined in 10 CFR 150.11 as enriched uranium not exceeding 350 grams, uranium-233 not exceeding 200 grams, plutonium not exceeding 200 grams, or mixtures where the sum of the fractions is less than unity. In both Agreement States and non-Agreement States, an NRC license is required, pursuant to 10 CFR Part 70, "Domestic licensing of special nuclear material," for persons who possess quantities of SNM in excess of the 10 CFR 150.11 limits. As it pertains to disposal of SNM at LLW disposal facilities, the concept of quantities not sufficient to form a critical mass has been applied to above ground possession. Once the SNM was disposed (i.e., placed into a disposal trench), this quantity of SNM was not considered to apply to the 10 CFR 150.11 limits.

The disposal of LLW is regulated in 10 CFR Part 61,"Licensing requirements for land disposal of radioactive waste." LLW, which contains SNM, is currently disposed of at three facilities (Barnwell, South Carolina; Hanford, Washington; and Clive, Utah). All of these facilities are licensed by Agreement States under 10 CFR Part 61 equivalent regulations. The Barnwell and Hanford facilities were licensed by the NRC under 10 CFR Part 70 to receive, possess, store, and dispose of kilogram quantities of SNM. In 1997, these facilities requested that the SNM possession limits be reduced to the 10 CFR 150.11 limits and that the NRC licenses be transferred to the respective Agreement States. The State of Washington and the State of South Carolina retained criticality safety measures from the NRC Part 70 licenses. The State of Utah Envirocare license did not address criticality safety beyond the 10 CFR 150.11 mass limits. In July 1999, Envirocare requested that the State of Utah amend its license to incorporate the criticality safety conditions in the NRC Order to Envirocare, dated May 24, 1999 [1].

ENVIROCARE ORDER

In May 1997, the State of Utah determined that Envirocare had exceeded the SNM possession limits in its State of Utah license. Consequently, NRC Region IV conducted an inspection of the facility in June 1997. As a result of that inspection, NRC issued a Confirmatory Order on June 25, 1997, that required Envirocare, in part, to reduce its possession of SNM and to submit a compliance plan (CP) to NRC for approval. As part of the approved CP, trucks containing SNM waste could proceed to the disposal cell (assuming the conditions stated in the Confirmatory Order apply) without counting the SNM waste as part of Envirocare's possession inventory. This waste was considered "in-transit," under the exemption of 10 CFR 70.12, because the carrier was still present.

Before the Confirmatory Order and CP, rail shipments were transported directly to a rail siding adjacent to the site. Rail cars were staged on the siding until the waste could be moved onto the site within licensed limits. Subsequent to the Confirmatory Order and CP, it became operationally advantageous for Envirocare to receive SNM waste via truck shipments. Thus, the Confirmatory Order and CP may have led to a practice of transferring of SNM waste from rail

cars to trucks in Salt Lake City. Some trucks and SNM waste were staged at a nearby industrial facility and did not go directly to the disposal site because of the SNM possession limit. NRC concluded that this process resulted in a change in the mode of transportation of waste to the site (i.e., more truck shipments), leading to a slightly higher probability of a transportation accident. Moreover, the increased waste handling increased the possibility of container rupture and resultant spillage in a metropolitan area. In addition, SNM waste was being staged while in transit at nearby unlicensed industrial facility. Although that practice conformed to applicable NRC and DOT regulations, it was regarded as less safe and a direct result of conditions in the CP.

To resolve this issue, NRC explored ways in which rail cars could be allowed to proceed directly to the site. If the SNM waste was shipped in accordance with 10 CFR Part 71,"Packaging and transportation of radioactive material," and applicable DOT regulations, these conditions were sufficiently protective while the waste was on the rail cars, regardless of being located inside or outside the site boundary. NRC further evaluated whether concentration limits could be established to prevent an inadvertent criticality. Considering that concentration limits could be established, an acceptable rationale, therefore, existed for allowing above-ground storage of similar material in a comparable or more dispersed configuration. This rationale supported NRC taking action to alleviate the regulatory constraint that appeared to have led to the less than optimal practice, described above, for transporting SNM waste to Envirocare.

NRC decided that the appropriate means for resolving this issue was through the issuance of an Order to Envirocare. To support this Order, a Safety Evaluation Report [2] and Environmental Assessment [3] were prepared. The Environmental Assessment was published in the Federal Register (99 FR 12241) [4]. The Order became effective when the conditions of the Order were incorporated into Envirocare's State of Utah license.

Based on its analysis of the operations and waste forms at the Envirocare site, NRC concluded that waste processing and disposal operations could be conducted with acceptably low risk of nuclear criticality subject to certain conditions (Attachment 1). Conceptually, the conditions are SNM isotope concentration limits (Condition 1); bulk chemical limits (Condition 2); unusual moderator limits (Condition 3); soluble uranium limits (Condition 4); mixed waste processing limits (Condition 5); waste characterization and certification requirements (Condition 6); and waste receipt sampling condition (Condition 7). The basic approach is the specification of four sets of technical criticality safety limits (Conditions 1 through 4), then the provision in condition 6 for a certification and waste characterization assuring that these limits will not be exceeded. The waste sampling plan of condition 7 provides for detection of erroneous shipment of waste not complying with the concentration limits. Condition 5 limits mixed waste-processing activities to those currently used by Envirocare. The technical bases for conditions 1 through 4 are summarized below.

Concentration Limits for Subcriticality

For a criticality to occur, special conditions involving a number of factors must occur. Important factors that affect the criticality safety of a LLW disposal site are: (1) the isotope, (2) enrichment, (3) mass, (4) concentration, and (5) presence of neutron moderating and absorbing materials. Each of these is discussed below.

(1) Isotope: The SNM isotopes present in LLW are dependent on the waste stream. The vast majority of SNM waste is generated from the production of nuclear fuel for nuclear power plants and from LLW generated by nuclear power plants. Of the SNM isotopes, uranium-235 is the most common. Large quantities of plutonium and uranium-233 (the other SNM isotopes) are not present in the commercial waste. However, these materials are present in Department of Energy (DOE) facility waste, and some DOE waste is being shipped to commercial LLW disposal facilities. The criticality characteristics vary among the SNM isotopes.

(2) Enrichment: Enrichment is a ratio of the weight of uranium-235 to the weight of the total uranium and is commonly expressed as a percent. Natural uranium, found in most soils, has an average enrichment of 0.71 percent. In order to be used as nuclear fuel, natural uranium must be enriched in uranium-235. Most nuclear fuel is enriched to less than 6 percent; however, some nuclear fuel for special reactors such as those in naval vessels is enriched to much higher values. At enrichments less than about 0.96 percent, criticality is not possible regardless of the mass or concentration. As enrichment increases, criticality becomes a greater concern.

(3) Mass: The mass of SNM in individual waste packages or in accumulations of waste packages will effect the criticality characteristics of the system. In general, the criticality concern increases with the mass of SNM present. There is a minimum mass required to achieve criticality. This minimum critical mass varies depending on the isotope.

(4) Concentration: Similar to mass, the concentration of the SNM in the waste will effect the criticality characteristics of the system. In general, the criticality concern increases with the concentration of the SNM. There is a minimum concentration required to achieve criticality. This minimum critical concentration varies depending on the isotope.

(5) Presence of neutron moderator and absorbers: Neutrons that are produced during a fission have a relatively high energy and are termed "fast" neutrons. Moderators are materials that reduce the energy or slow neutrons. This is important because uranium-235 is much more likely to be fissioned by slow neutrons than by fast neutrons. Therefore, the presence of moderator materials can increase the criticality concern. Elements such as hydrogen and carbon are particularly good moderators. Because water is abundant and is a very efficient moderator, assuming water is present is a common approach in evaluating the criticality significance of situations. However, there are certain materials such as beryllium,

graphite, and deuterium that are more efficient moderators than water. These materials are commonly termed "unusual" moderators.

Absorbers are materials that absorb or capture neutrons. Because capturing neutrons prevents those neutrons from possibly causing a fission, the presence of absorber materials will decrease the criticality concern. Most materials act both as a moderator and an absorber to varying degrees. In analyzing the criticality hazard of waste at LLW disposal facilities, it is conservative to assume that moderators will be present in optimal amounts. The presence of absorber materials is not limited by regulations. These materials, such as iron, calcium, etc., are present in LLW and in the waste containers. However, the amount and distribution of absorbers cannot be assured, so they are typically omitted in analyzing criticality hazards. For example, although a steel drum acts as an absorber, the drum will corrode within tens of years and can no longer be depended on to contain the waste and act as an absorber.

In establishing the uranium-235 concentration limits, NRC used criticality calculations in two studies prepared by Oak Ridge National Laboratories (ORNL), NUREG/CR-6505 Volumes 1 and 2 [5 and 6]. In order to allow Envirocare greater flexibility, NRC established a concentration limits for 100 percent and 10 percent enriched uranium. In addition to these studies, ORNL performed similar criticality calculations for uranium-233, plutonium-239, and mixtures of plutonium that will be documented in a NUREG/CR on emplacement criticality guidance [7].

In the ORNL studies, silicon dioxide (SiO_2) was used to represent the waste matrix. The SNM concentrations presented in the ORNL studies are assumed to be uniformly distributed and are expressed in grams of SNM isotope per gram of SiO_2. It is also assumed that unusual moderators are not present. The studies provide the neutron multiplication factor (k) for infinite media systems (k-infinity) over a range of SNM concentrations. (A k-value greater than one would represent a critical condition.) The studies also provide dimensions and areal densities for infinite slabs and linear densities for cylinders, and diameter and minimum SNM mass for finite spheres corresponding to a k-effective of 0.95 over a range of concentrations. NRC conservatively used the infinite media results in developing the concentration limits.

In establishing operational concentration limits and considering that concentration will be the primary criticality control, NRC reduced the subcritical limit to account for operational uncertainties. Part of the concern in establishing the operational concentration limit was based on how accurately generators could determine the concentration of the SNM in the waste. Typically, uranium-235 and other fissile isotopes are measured using gamma spectroscopy methods to measure the activity of the isotope and/or daughter products. The uncertainties associated with this method are based on a number of factors including count time, type of detector, container geometry, density of the waste, distribution of SNM within the container, etc. NRC considers that a reasonable measurement uncertainty value (one-sigma) would be in the range of 15 percent. A 30 percent (two-sigma) was used in calculating the operational limit to increase the confidence level that the concentration of the waste based on measurement would not exceed the subcritical value. Other radiochemistry techniques may be used to quantify the

concentration of these radionuclides. These techniques typically have lower measurement uncertainty levels, but introduce sampling uncertainty. The measurement uncertainty levels are included in condition 1 and represent 15 percent of the maximum concentration value. A concentration value was used for the measurement uncertainty rather than a percentage value to allow greater flexibility for generators with waste having very low SNM concentrations.

Table 1 shows the conversion from activity of the SNM per gram of waste (as presented in the NUREG/CR-6505 reports) to grams of SNM per gram of waste (as presented in the Order). The maximum concentrations in the second column are given in picoCuries per gram of waste. The fourth column of Table 1 converts these concentrations to a mass ratio, that is, mass of SNM per mass of waste, by dividing by the specific activity.

CONVSERSION OF MAXIMUM CONCENTRATION TO MASS RATIO
TABLE 1

Radionuclide	Maximum Concentration (pCi/g waste)	Specific Activity of Nuclide (Ci/g nuclide)	Max. Concentration As Mass Ratio (g nuclide/g waste)
<10% U-235	1900	2.16e-06	8.80e-04
>10% U-235	1190	2.16e-06	5.51e-04
U-233	7.5e-08	9.70e-03	7.28e-06
Pu-239	1.0e-08	6.20e-02	1.61e-07
Pu-240	1.0e-08	2.30e-01	4.35e-08
Pu-241	3.5e-07	1.00e+02	3.50e-09

Unlike the above isotopes, criticality concentration limits for the other plutonium isotopes in an infinite matrix of SiO_2 have not been determined. Some of the common plutonium isotopes such as plutonium-238, plutonium-240, plutonium-242 and plutonium-244 are fissionable but not fissile. Non-fissile fissionable materials require high-energy neutrons to maintain a fission chain reaction; while, fissile material (U-233, U-235, Pu-236, Pu-239, Pu-241, and Pu-243) can be fissioned by neutrons of any energy. To evaluate the criticality significance of these other plutonium isotopes, NRC compared the minimum critical masses (typically optimally moderated spheres) of these isotopes with the minimum critical mass of plutonium-239 and compared the mass-based radiological concentration limits of these isotopes with the subcritical concentration for plutonium-239. Table 2 below illustrates this point. Because the minimum critical masses for the other plutonium isotopes are significantly higher than plutonium-239 and the concentration limit of the other plutonium isotopes (based on radiological safety considerations) are significantly less than the subcritical concentration of plutonium-239, NRC concluded that

the concentration limits for the other plutonium isotopes will not contribute significantly to criticality.

RATION OF CONCENTRATION LIMITS AND SUBCRITICAL LIMITS
TABLE 2

Nuclide	Minimum Critical Mass (**Mc**) (grams)	Mc(nuclide)/ Mc(Pu-239)	Concentration Limit (**CL**) (g isotope/g waste)	CL(isotope)/ Subcritical Concentration (Pu239)
Pu-236	*	NA	9.40e-13	3.4e-09
Pu-238	4.00e+03	9.3	5.88e-10	2.1e-06
Pu-239	4.50e+02	1.0	1.61e-07	5.8e-04
Pu-240	1.90e+04	42.2	4.35e-08	1.6e-04
Pu-242	5.60e+04	124.0	2.56e-06	9.2e-03
Pu-243	*	NA	1.90e-16	6.8e-13
Pu-244	*	NA	2.80e-05	1.0e-01

* - Data not provided in literature
NA - Not applicable

Bulk Chemical Limits

As discussed above, SiO_2 was assumed to conservatively represent the waste matrix. Evaluations by ORNL for a range of compounds also confirmed that silicon dioxide is likely to be the most reactive feasible waste matrix. Other likely soil or waste constituents, such as iron, aluminum, and calcium act as neutron absorbers. Similarly the hydrogen in water acts as a neutron absorber more effectively than silicon for low concentrations of SNM in a waste matrix. Disposal of pure bulk chemical compounds containing some enriched uranium would raise the question of whether there are chemical compounds more reactive than pure SiO_2. ORNL performed additional studies replacing the Si in the SiO_2 matrix with other common elements and determined that beryllium, bismuth, carbon, helium, oxygen, fluorine, and magnesium produced more reactive systems. Of these elements, pure helium and oxygen are gases and would not be expected to be present in significant quantities in the waste. Beryllium and pure carbon (i.e., graphite) are unusual moderators and are limited in condition 2. Although magnesium, fluorine, carbon, and other oxide forms are present in earth materials and in fuel cycle waste, these chemicals are typically not present in bulk quantities or in "pure" form. The presence of bismuth is not anticipated to be significant in waste. To limit the presence of these chemicals from

occurring in bulk quantities in pure form, Condition 2 was included to preclude this for waste shipped to Envirocare. As part of its mixed waste processing, Envirocare adds magnesium oxide. For the general case, 20 percent magnesium oxide was assumed, and the uranium-235 concentration values presented in the ORNL studies were reduced to reflect this magnitude of magnesium oxide.

Unusual Moderator Limits

The concentration values reported in NUREG/CR-6505 Volumes 1 and 2 are based on the assumption that unusual moderators are not present. Unusually effective neutron moderating materials, such as beryllium, graphite, or heavy water, could provide a more reactive matrix. Previous evaluations have shown that the presence of large amounts of beryllium can permit criticality to occur at lower concentrations of SNM in soil. Therefore, limiting unusual moderators was required to assure the effectiveness of the SNM concentration limits in maintaining criticality safety. Because prohibiting unusual moderators could result in problems demonstrating compliance, NRC decided to set a finite maximum limit on unusual moderators. In discussions with Envirocare, a limit of one percent of the SNM mass was selected as a bounding value. ORNL performed additional calculations that included varying amounts of beryllium, graphite, and heavy water within the silicon dioxide waste matrix. As discussed above, this magnitude of unusual moderators was used to calculate the general case concentration limits.

During the development of the exemption, Envirocare requested a concentration limit for uranium-235 without regard for the beryllium or magnesium oxide content. ORNL performed additional criticality analyses varying the beryllium and magnesium oxide content to calculate a subcritical limit for uranium-235 above 10 percent enrichment. A subcritical limit for this case of 160 pCi/g was obtained. Envirocare also requested a limit for beryllium and magnesium oxide that would result in a uranium-235 concentration limit of 680 pCi/g for 10 percent enrichment or greater. ORNL performed additional criticality analyses and determined that the associated sum of beryllium and magnesium should be less than 49 percent. These additional concentration limits are included in Condition 1.

Soluble Uranium Compounds

NRC examined mechanisms that could increase the concentration of the SNM in the waste. One of these mechanisms is that highly soluble uranium could be readily leached with water and concentrate. Highly soluble forms of uranium include, but are not limited to: uranium sulfate, uranyl acetate, uranyl chloride, uranyl formate, uranyl fluoride, uranyl nitrate, uranyl potassium carbonate, and uranyl sulfate. NRC considered that leaching or washing of soluble uranium from waste in containers could occur and collect in a corner of the container.

The maximum calculated amount of uranium-235 that could be permissible at the maximum concentration (1300 pCi U-235/g) for a large intermodal container (70 yd^3) assuming the density

of the waste was 1.6 g/cm^3 was calculated to be 51.6 kg. This value was compared with the minimum critical mass for uranium-235 (760 g). In order to insure criticality safety, the mass of soluble uranium should be a fraction of the minimum critical mass. Consistent with 10 CFR Part 150, NRC selected a mass limit of 350 g of soluble uranium-235 or 200 g of soluble uranium-233 as being acceptable to insure subcriticality. For mixtures of uranium-233 and uranium-235, the sum of the fractions rule would apply. It was further recognized that the mass of uranium will be limited by the consignment mass limits in 10 CFR Part 71.

POSSIBLE REGULATORY CHANGES

As discussed above, the regulation of SNM LLW disposal changed in 1997 when Chem-nuclear Systems Inc. and U.S. Ecology Inc. requested that the SNM possession limits in their NRC Part 70 license be reduced and that the licenses be transferred to the States. Now, SNM waste is only disposed of at LLW disposal facilities licensed by Agreement States. These actions caused NRC to reevaluate its involvement with SNM and LLW. Several issues were raised to the Commission in SECY-98-010 [8], including possible changes to 10 CFR 150.

In SRM-SECY-98-010 and SRM-SECY-98-226 [9], the Commission requested the staff to evaluate the impacts of the Envirocare Order and to consider modifying 10 CFR 150.10 to include a concentration-based exemption limit in addition to the current mass-based exemption limit.

CONCLUSION

NRC examined a basis for establishing a concentration-based criticality safety limit for SNM in LLW. This concept was incorporated into an Order to Envirocare that allows Envirocare exceed the SNM mass limits in 10 CFR 150, subject to the conditions of the Order. NRC is continuing to work with the State of Utah and Envirocare to evaluate the usefulness of this concept. In the long term, NRC is considering modifying 10 CFR 150 to incorporate a concentration-based limit in addition to the current mass-based limit.

REFERENCES

[1] USNRC, Order to Envirocare of Utah, Inc., U.S. Nuclear Regulatory Commission, Washington, DC, May 1999 .

[2] USNRC, "Safety Evaluation Report Regarding the Proposed Exemption from Requirements of 10 CFR Part 70," U.S. Nuclear Regulatory Commission, Washington, DC, May 1999.

[3] USNRC, "Environmental Assessment and Finding of No Significant Impact for Exemption from certain NRC Licensing Requirements for Special Nuclear Material for Envirocare of Utah, Inc," U.S. Nuclear Regulatory Commission, Washington, DC, May 1999.

[4] USNRC, "Environmental Assessment and Finding of No Significant Impact for Exemption from certain NRC Licensing Requirments for Special Nuclear Material for Envirocare of Utah, Inc.," Federal Register, Vol.64, No. 93, Friday May 14, 1999, pp 26463-26465.

[5] Toran, L.E., et al., "The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities," NUREG-6505, Volume 1, U.S. Nuclear Regulatory Commission, Washington, DC, June 1997.

[6] Toran, L.E., et al., "The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities," NUREG-6505, Volume 2, U.S. Nuclear Regulatory Commission, Washington, DC, August 1998.

[7] Elam, K.R., et al., "Emplacement Guidance for Criticality Safety in Low-Level Waste Disposal," NUREG-6626, U.S. Nuclear Regulatory Commission, Washington, DC, Draft.

[8] USNRC, "Petition for Envirocare of Utah to Possess Special Nuclear Material in Excess of Current Regulatory Limits," SECY-98-010, U.S. Nuclear Regulatory Commission, Washington, DC, January 1998.

[9] USNRC, "Staff Requirements - SECY-99-226 – Issuance of a Section 274f Atomic Energy Act Order to Exempt Envirocare of Utah, Inc. from the Licensing Requirements for Special Nuclear Material in Diffuse Waste That will be Regulated by the State of Utah" SRM- SECY-99-0226, U.S. Nuclear Regulatory Commission, Washington, DC, October 1998.

CONDITIONS IN THE ORDER TO ENVIROCARE
DATED MAY 7, 1999

1. Concentrations of SNM in individual waste containers must not exceed the following values at time of receipt:

Radionuclide	Maximum Concentration (pCi/g)	Measurement Uncertainty (pCi/g)
U-235[a]	1,900	285
U-235[b]	1,190	179
U-235[c]	160	24
U-235[d]	680	102
U-233	75,000	11,250
Pu-236	500	75
Pu -238	10,000	1,500
Pu-239	10,000	1,500
Pu-240	10,000	1,500
Pu-241	350,000	50,000
Pu-242	10,000	1,500
Pu-243	500	75
Pu-244	500	75

a - for uranium below 10 percent enrichment and a maximum of 20 percent MgO of the weight of the waste

b - for uranium at or above 10 percent enrichment and a maximum of 20 percent MgO of the weight of the waste

c - for uranium at any enrichment with unlimited MgO or beryllium

d - for uranium at any enrichment with sum of MgO and beryllium not exceeding 49 percent of the weight of the waste

The measurement uncertainty values in column 3 above represent the maximum one-

sigma uncertainty associated with the measurement of the concentration of the particular radionuclide.

The SNM must be homogeneously distributed throughout the waste. If the SNM is not homogeneously distributed, then the limiting concentrations must not be exceeded on average in any contiguous mass of 145 kilograms.

2. Except as allowed by notes a, b, c, and d in Condition 1, waste must not contain Apure forms@ of chemicals containing carbon, fluorine, magnesium, or bismuth in bulk quantities (e.g., a pallet of drums, a B-25 box). By Apure forms,@ it is meant that mixtures of the above elements such as magnesium oxide, magnesium carbonate, magnesium fluoride, bismuth oxide, etc. do not contain other elements. These chemicals would be added to the waste stream during processing, such as at fuel facilities or treatment such as at mixed waste treatment facilities. The presence of the above materials will be determined by the generator, based on process knowledge or testing.

3. Except as allowed by notes c and d in Condition 1, waste accepted must not contain total quantities of beryllium, hydrogenous material enriched in deuterium, or graphite above one percent of the total weight of the waste. The presence of the above materials will be determined by the generator, based on process knowledge, physical observations, or testing.

4. Waste packages must not contain highly water soluble forms of uranium greater than 350 grams of uranium-235 or 200 grams of uranium-233. The sum of the fractions rule will apply for mixtures of uranium-233 and uranium-235. Highly soluble forms of uranium include, but are not limited to: uranium sulfate, uranyl acetate, uranyl chloride, uranyl formate, uranyl fluoride, uranyl nitrate, uranyl potassium carbonate, and uranyl sulfate. The presence of the above materials will be determined by the generator, based on process knowledge or testing.

5. Mixed waste processing of waste containing SNM will be limited to stabilization (mixing waste with reagents), micro-encapsulation, and macro-encapsulation using low-density polyethylene.

6. Envirocare shall require generators to provide the following information for each waste stream:

Pre-shipment

1. Waste Description. The description must detail how the waste was generated, list the physical forms in the waste, and identify uranium chemical composition.
2. Waste Characterization Summary. The data must include a general description of how the waste was characterized (including the volumetric extent of the waste,

and the number, location, type, and results of any analytical testing), the range of SNM concentrations, and the analytical results with error values used to develop the concentration ranges.

3. Uniformity Description. A description of the process by which the waste was generated showing that the spatial distribution of SNM must be uniform, or other information supporting spatial distribution.

4. Manifest Concentration. The generator must describe the methods to be used to determine the concentrations on the manifests. These methods could include direct measurement and the use of scaling factors. The generator must describe the uncertainty associated with sampling and testing used to obtain the manifest concentrations.

Envirocare shall review the above information and, if adequate, approve in writing this pre-shipment waste characterization and assurance plan before permitting the shipment of a waste stream. This will include statements that Envirocare has a written copy of all the information required above, that the characterization information is adequate and consistent with the waste description, and that the information is sufficient to demonstrate compliance with conditions 1 through 4. Where generator process knowledge is used to demonstrate compliance with Conditions 1, 2, 3, or 4, Envirocare shall review this information and determine when testing is required to provide additional information in assuring compliance with the conditions. Envirocare shall retain this information as required by the State of Utah to permit independent review.

At receipt

Envirocare shall require generators of SNM waste to provide a written certification with each waste manifest that states that the SNM concentrations reported on the manifest do not exceed the limits in Condition 1, that the measurement uncertainty does not exceed the uncertainty value in Condition 1, and that the waste meets conditions 2 through 4.

7. Sampling and radiological testing of waste containing SNM must be performed in accordance with the Utah Division of Radiation Control license Condition 58.

8. Envirocare shall notify the NRC, Region IV office within 24 hours if any of the above conditions are violated. A written notification of the event must be provided within 7 days.

9. Envirocare shall obtain NRC approval prior to changing any activities associated with the above conditions.