WM'01 Conference, February 25-March 1, 2001, Tucson, AZ

DISPOSITION OF BULK MATERIALS FROM DECOMMISSIONING

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ABSTRACT

Decommissioning of commercial nuclear power plants generates large quantities of solid bulk materials such as concrete, metal, and demolition debris. Disposition of such materials can have large impact on the overall decommissioning cost. Yet, there are no clear and cost-effective alternatives for the disposal of this material from regulatory perspective.

In this paper, we present an assessment of the clearance methodologies and their applicability to disposition of bulk materials originating from decommissioning of nuclear power plants. We also describe the approach that we have taken at the Big Rock Point Decommissioning Project. To our knowledge, this is the first time such an approach for the release of large quantities of bulk materials from a decommissioning site has been proposed.

INTRODUCTION

The regulatory framework applicable to the release of solid materials is in a transition phase. In the past, clearance methodologies in the United States have relied primarily on the use of surficial contamination guidelines in Regulatory Guide 1.86. The guide does not include volumetric contamination guidelines and the surface contamination levels are not dose-based. The Nuclear Regulatory Commission (NRC) is in the process of developing a methodology for the clearance of solids based on pathways analyses. The methodology provides development of guidelines for various materials for disposal and recycle through pathways analysis. However, the effort is currently on hold.

Because of lack of specific guidance, decommissioning projects must rely on a case-by-case approvals from NRC to release bulk materials from the site. At the Big Rock Point (BRP) decommissioning project, we are facing the same dilemma. Consumers Energy has committed to restoring the site to "greenfield" conditions. This commitment means that when the decommissioning process has been completed, all former structures will have been removed and the site will be available for use without any restrictions on future site uses. It is estimated that the removal of the reactor building and other structures will result in 84.5 million lbs of concrete debris.

Disposition of such materials at BRP is being addressed through the Bulk Materials Control Program (1). A license amendment has been submitted to NRC for approval of a clean disposal level for our site at Big Rock Point. This level has been derived based on a comprehensive pathways analysis for disposal of the material in a Michigan Class II landfill and ensuring that the dose to an average member of the critical group remains below 1 mrem/y.

In this paper, we present an assessment of the clearance methodologies and their applicability to disposition of bulk materials originating from decommissioning of nuclear power plants. We also describe the approach that we have taken at the Big Rock Point Decommissioning Project.

SUMMARY OF RELEASE GUIDELINES

The regulatory framework applicable to the release of solid materials is in a transition phase. In the past, clearance methodologies have relied primarily on the use of surficial contamination guidelines given in Regulatory Guide 1.86 (2). The guide does not include volumetric contamination guidelines and the surface contamination levels are not dose-based. Nevertheless, surficial contamination guidelines have been used in the past for license termination, not only by the NRC licensees, but also at numerous Department of Energy (DOE) sites.

The NRC is in the process of developing a methodology for the clearance of solids based on pathways analyses. A draft report NUREG-1640, "Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities" (3), was issued for public comment in 1999 and an Issues Paper on the release of solid materials was published in the Federal Register. The NRC also conducted a series of workshops on this rulemaking effort during 1999. The metal and concrete industries strongly opposed any attempts at establishing recycle standards. Some public groups also objected strongly to the rulemaking effort. The NRC has asked the National Academy of Sciences to study the alternatives and the rulemaking is on hold until that study is complete.

Recently however, a number of other related regulatory developments have taken place. These have significantly altered the criteria for license termination after the decommissioning of a site and may significantly change the criteria for releasing bulk solid materials during decommissioning. The most important of the new regulatory developments is the publication of the License Termination Rule in 1997 (4). It sets a dose limit of 25 mrem/y to an average member of the critical group for unrestricted release of a decommissioned site (10 CFR 20.1402). The methodology for compliance with the rule is another important development. The compliance now must be demonstrated through pathways analysis modeling and a Final Status Survey of the site under MARSSIM (5). The NRC has completed a number of guidance documents in this area including the NUREG-1727 (Standard Review Plan) (6), NUREG- 1700 (7), Regulatory Guides 1.184 (8) and 1.185 (9); and the Dand D screening code. Note that the draft regulatory guide DG-4006 (10) is now included in the Standard Review Plan. For decommissioning projects, it is a possible option for the licensees to decontaminate structures as necessary and include them in the final status survey. Once the site license is terminated, the structures can be left intact or demolished.

A number of other developments have also taken place at the national and international level. American National Standards Institute (ANSI) has published a standard, ANSI N13.12 (11), which provides both surface and volumetric radioactivity standards for clearance of equipment, materials, and facilities. The standard uses 1 mrem/y as the dose criteria and the surficial levels are comparable to past practices.

Nevertheless this standard is not accepted or endorsed by any regulatory agency and there are no consistent release criteria at the national level.

The DOE has recently initiated an effort to establish their criteria in the area of materials release through a publication of notice of intent in the Federal Register on October 12, 2000 (12). The DOE Order 5400.5 is being amended with additional chapters that cover the issues of release of materials and property with residual radioactive contamination.

On the international scene, International Atomic Energy Agency (IAEA) and the European Commission (EC) have established an essentially dose based criteria of 10 μSv/y (1 mrem/y), even though the derived mass-specific and surface-specific levels may vary in different countries. Some relevant documents are IAEA-TECDOC-855 (13), Safety Series No. 89 (14), and European Commission Radiation Protection 89 (15). The IAEA uses the concept of "exclusion", "exemption" and "clearance". The amount of activity related to 10 μSv/y is considered "negligible radioactivity" and it is taken as the criterion for clearance. By contrast, the NRC guidance does not define a dose level for clearance.

However there are inconsistencies in these approaches. The values derived from draft NUREG-1640 differ significantly from EC and IAEA values. For examples, for Co-60 (and the dose criteria of 10 μ Sv/y), the EC value for clearance of all metals is 1 Bq/g (0.6 Bq/g in Germany), it is 0.04 Bq/g in NUREG-1640, which is 25 times more restrictive. Similarly, a comparison with IAEA values for Co-60 for all materials shows that the NUREG-1640 value is approximately 10 times more restrictive (0.039 Bq/g as compared to 0.3 Bq/g from IAEA).

For surficial guidelines, NUREG-1640 also compares inconsistently with Reg. Guide 1.86. For example, for Co-60, it provides a much more restrictive value of 280 dpm/100 cm^2, as compared to a value of 5000 dpm/100 cm^2 in the guide. The comparable value in the ANSI N13.12 standard is 6000 dpm/100 cm^2.

Clearly, there is no consensus standard for the release of bulk materials with residual contamination at the national and international level.

HISTORICAL REVIEW OF FREE RELEASE

Operators of NRC- regulated nuclear reactors have performed free release of material under the no detectable concept. For solid items this requirement had the licensees survey all accessible areas with a hand held small area Geiger Mueller detector or equivalent in low background environments. A Minimum Detectable Count Rate (MDCR) would be calculated and any detected counts above the MDCR would be considered unacceptable for release. The process was open to error by several avenues: it addressed surface areas only; the process was open to technician survey error; detector efficiency variance due to changes in geometry; varying redionuclide mixes; variation in background levels; and the items themselves may have inaccessible areas making the process nonviable.

The industry approach to the clearance of solid material has involved the application of Reg. guide 1.86 which only addresses the surface contamination of solid objects and not the volumetric values. The NRC has initiated rulemaking efforts to establish methodologies and standards for release of solid volumetric material, but the process is currently on hold and may not be complete for several years as mentioned earlier.

BRP PROJECT BACKGROUND

Big Rock Point is a 67- MWe boiling water reactor (BWR) located on the Eastern Shore of Lake Michigan approximately 50 miles from the tip of Michigan's Lower Peninsula. It received its operating license from the Atomic Energy Commission (AEC) on August 30, 1962 and was Michigan's first and the United States' fifth nuclear power reactor. The first five years of plant operation were devoted to research and development as part of the AEC's Power Reactor Demonstration Program. The plant produced electricity until it was shut down for the last time on August 29, 1997.

The plant is currently undergoing decommissioning and dismantlement with a scheduled completion date of July 2005. The 441 spent fuel bundles will be moved into dry storage containers at the site in late 2001 or early 2002. Unlike past decommissioning projects, Big Rock Point's 600-acre plant site will be returned to a greenfield state prior to license termination. The final site release survey will be performed after the site has been returned to the greenfield condition. Accomplishing this precedence-setting goal creates several hurdles that must be overcome to be successful.

In March 1999, Consumers Energy started development of a free release program for large quantities of solid material associated with the decommissioning of its site. The project involves decommissioning the reactor and all of the associated facilities. Consumers Energy is committed to restoring the site to a greenfield condition which requires the removal of all building material prior to license termination. The BRP Radiation Protection management staff determined that the typical methods used to comply with NRC regulations for analyzing volumetric material for radionuclides would not fulfill the demands of a facility undergoing decommissioning. The challenge at hand is to comply with regulatory requirements and put into production a large-scale bulk release production program.

LICENSING PREPARATIONS

Termination of a reactor operating license under the provisions of 10 CFR 20, Subpart E is permitted with trace levels of licensed radioactive materials remaining providing that the residual radioactivity does not result in a calculated total effective dose equivalent (TEDE) exceeding 25 mrem per year. Thus, it is possible to terminate the license for the site with decontaminated structures intact. However, release of debris from these structures prior to license termination with these same residual levels of radioactivity is not permitted under existing regulations. 10 CFR 20, Subpart K, §20.2001 requires that licensed radioactive material be disposed of only through (1) transfer to an authorized recipient, (2) decay in storage, (3) release in effluents within the limits in §20.1301, or (4) as authorized under §§20.2002, 20.2003, 20.2004, or §20.2005. Subpart K does not provide a regulatory basis for demonstrating the absence of licensed radioactive materials when they could potentially exist.

Since there is no regulatory basis for demonstrating the absence of licensed radioactive materials, the NRC has provided guidance on how hard to look for both surface and bulk material contamination for items and material to be released from restricted areas as clean. However, this guidance was not developed for disposal of demolition debris during a decommissioning project. Furthermore, if this guidance is used, a licensee is always subject to a third party using more sensitive instrumentation and identifying residual radioactivity on or in materials that had been released from the site. This would result in a violation of 10 CFR 20.2001.

Because of this, Big Rock Point has opted to request a license amendment to establish how hard to look for licensed radioactive material in demolition debris in our licensing basis. The NRC accepted the submission of the application on September 14, 2000 and has established a 12-month review schedule.

LICENSE AMENDMENT REQUEST CONTENTS

The license amendment that Consumers Energy has requested is in the form of a Technical Specification change that includes new definitions for:

- Bulk Materials Control Manual
- Demolition Debris
- Detection Capability
- Radiologically Clean.

The request also includes a new Limiting Condition for Operation (LCO) and a new Administrative Control requirement to establish a Bulk Materials Control Program (BMCP), which is to be contained in a new Bulk Materials Control Manual (BMCM), and implemented and controlled by facility procedures. The BMCM was also submitted to the NRC along with the license amendment request.

The LCO requires that demolition debris shall be surveyed prior to release with a bulk container assay system having a detection capability for principal gamma emitters of 6 pCi/g for C0-60 or 14 pCi/g for Cs-137. Another stipulation is that disposal of the demolition debris shall be in a State of Michigan licensed Class II landfill. If the bulk container assay system detects licensed radioactive material at or above the detection capability in a container of demolition debris, then the licensed radioactive material shall be identified and removed and the container, re-assayed, or the contents of the container shall be transported as radioactive material to an offsite contractor for secondary waste processing and disposal, or the contents of the bulk container shall be disposed of as radioactive waste.

BULK MATERIALS CONTROL MANUAL

The BMCM is a manual similar to an Offsite Dose Calculation Manual (ODCM). The BMCM contains the specifications and methodology to ensure that the LCO and the BMCP program requirements are appropriately implemented. Part 1 of the BMCM contains the specifications that are to be implemented and controlled by facility procedures. Part 2 contains the methodology for specification implementation. Part 3 contains record requirements, Part 4 QA/QC considerations and Part 5 reporting requirements for changes to the BMCM.

The BMCM specifications require that structural surfaces be screened for both total and removable activity prior to final demolition. Total contamination monitoring shall be performed with instrumentation and techniques (i.e., survey scanning speed, counting times, in situ gamma spectrometry, background radiation levels, sample size, statistics etc.) sufficient to detect 5000 dpm per 100-cm^2 total (readily detectable) beta/gamma contamination averaged over a one square meter area. Removable contamination monitoring shall be performed with instrumentation and techniques (smears, counting times, background radiation levels, etc.) necessary to detect 1000 dpm per 100 cm^2 or greater (readily detectable) removable beta/gamma contamination.

Bulk container assay system instrumentation requirements are established in Part 1 of the BMCM. When demolition debris is collected in a container, the accumulation of small amounts of contamination that have escaped detection during the surface contamination surveying may be detected using a bulk container assay system that is sensitive to gamma radiation (e.g., by using sensitive high purity germanium detectors in a low-background area). The design of the bulk container assay system consists of three high purity germanium detectors and gamma spectroscopy operating system hardware and software. Part 1 of the BMCM establishes bulk container assay system instrumentation channel operability and surveillance requirements.

The methodology contained in Part 2 of the BMCM ensures that the bulk container assay system meets the detection capability specified in the LCO. The detection capability specified for Co-60 and Cs-137 assumes that only one of these radionuclides is potentially present in the demolition debris. If more than one radionuclides are potentially present in the demolition debris, the BMCM Part 2 methodology requires the calculation of new minimum detectable concentrations of principal gamma emitters for the bulk container assay system to ensure that the potential radiological consequence of disposal of demolition debris will not result in a TEDE of 1 mrem/y or more to an average member of the critical group from all exposure pathways.

This methodology also accounts for the potential presence of hard-to-detect radionuclides such as low energy beta and/or alpha emitters, which may also contribute to TEDE in the presence of gamma emitters detectable by the bulk container assay system.

The BMCM Part 2 methodology is based on an evaluation of potential exposure to an average member of the critical group from three potential exposure pathway scenarios. These three scenarios include: 1) a resident/farmer scenario which could develop after closure of the State of Michigan licensed landfill (50 years after disposal of the demolition debris); 2)landfill worker potential exposure during demolition debris disposition at the landfill and; 3) a transportation scenario for potential driver exposure during transportation of the demolition debris to the State of Michigan licensed landfill.

CONCRETE CHARACTERIZATION

Radiological characterization of concrete structures throughout the plant is the first step in our program. This effort consists of taking over 200 2"x6" core borings from each room or area on the BRP site. Each core will have a variety of analysis performed on it to determine what types of radioactive material is present and how far the contaminants have penetrated into the concrete. The types of analysis performed both on and off site include gamma ray spectroscopy, alpha and beta particle spectroscopy, and performing surface scanning with sensitive beta-gamma radiation detectors. The information generated from this effort will be utilized to generate instruction to workers on how deep concrete is to be removed in order to remove all radioactive material of plant origin. Radionuclide ratios are also established so a surrogate gamma emitting radionuclide can be used to determine the presence of a non-gamma emitting radionuclides such as Fe-55 or Ni-63.

The foundation of this program will be the removal of surface contamination to acceptable levels as determined by the NRC. The Big Rock Point site would then perform a survey of statistically significant and accessible areas with equipment capable of a beta-gamma detection equal to or less than 5000 dpm/100 cm^2 as required by IE Circular No. 81-07 and Information Notice 85-92. Pathway analysis techniques will be used to demonstrate that the surface and volumetric contamination levels do not pose any significant risk to an individual member of the critical group.

Consumers Energy is also developing special survey techniques for the final survey of the bulk material and shipment to a licensed landfill for disposal. The BRP program intends to consider concrete, steel and solid metals, and demolition debris as three new waste streams.

COUNTING EQUIPMENT CAPABILITIES

Counting equipment will be developed to allow Consumers Energy to count large volumes of solid material to levels that will meet regulatory standards. This level for concrete is anticipated to be 5 pCi / g Co-60. The technical requirements to assay 40,000 lbs of material to the required Lower Limit of Detection is being developed by Consumers Energy staff at Big Rock Point and its contractor GTS/Duratek. The approach

under consideration has three basic steps. The first step would require a detailed surface radiological contamination survey of floors, walls, and ceilings. Second, a quality control team would check the results of the survey team to verify the results of no detectable radiological contamination of plant origin. After the two survey results are reviewed by management, construction personnel would demolish the building and load the material into roll-of containers. Each roll-off container will contain approximately 40,000 lbs of concrete debris.

The concrete material will be processed through the bulk monitoring system where gamma ray spectroscopy detectors will be used to determine if any radioactive material of plant origin existed. All debris found to be clean will be shipped to a local industrial landfill licensed by the State of Michigan. Any material containing radioactive material of plant origin will be shipped to a radioactive waste disposal facility.

CURRENT STATUS

As mentioned earlier, Big Rock Point has opted to request a license amendment to establish how hard to look for licensed radioactive material in demolition debris in our licensing basis. The license amendment submission is technically supported by a Bulk Materials Control Manual, which provides the methodology and requirements for radiologically clean debris.

The NRC has accepted the submission of the license amendment application on September 14, 2000 and has established a 12-month review schedule.

CONCLUSIONS

Lack of specific NRC regulatory criteria necessitate a case-by-case approach in the area of solid materials release from licensed facilities.

At Big Rock Point, we have prepared and submitted a license amendment request to NRC to establish and implement a methodology for the release of bulk materials originating from decommissioning. The proposed methodology is based on a comprehensive pathways analysis and the potential dose to an individual remaining below 1 mrem/y TEDE. We are currently awaiting the NRC approval. Once this approval has been granted, we plan to demolish and dispose of the buildings prior to license termination of the site. We believe this route is more protective of the public health and safety in addition to being cost-effective.

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