

## AN ASSESSMENT OF THE FREE RELEASE CRITERIA FOR DECOMMISSIONING PROJECTS

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### ABSTRACT

As the number of nuclear facilities undergoing decommissioning in both federal and private sectors has continued to increase, free release of materials has become a very significant issue on the national scene. Most decommissioning projects involve large quantities of solid materials such as equipment, recyclable metal, and concrete. Thus, free release criteria have enormous impact on the overall decommissioning cost.

Consumers Energy is decommissioning its 75 MW BWR at Big Rock Point (BRP) and has committed to restoring the Big Rock Point 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 future use without any radiological restrictions. It is estimated that the removal of the reactor building and other structures will result in 84.5 million lb of concrete debris. Disposition of such materials at BRP is being addressed through the Solid Materials Release Program (SMRP) and we are looking at various options that are feasible.

This paper presents an assessment of the clearance methodology and its applicability to free release programs at decommissioning sites. It also describes the SMRP at BRP and the progress to date in assessing the possible options for dealing with these materials.

### INTRODUCTION

Decommissioning of nuclear facilities in both federal and private sectors has accelerated in the past few years. The trend is expected to continue as more utility and research reactors are shutdown for economic or political reasons and as many nuclear facilities in the federal sector are retired from service because they are no longer needed in the post cold war era. Since most decommissioning projects involve very large quantities of solid materials such as equipment, recyclable metal, and concrete, free release criteria have enormous impact on the overall decommissioning cost.

The regulatory framework applicable to the issue of release of solid materials is in a transition phase. While in the past, Regulatory Guide 1.86 has formed the basis for clean up levels, the Nuclear Regulatory Commission (NRC) is in the process of developing dose based criteria that will be applicable to release of solid materials with residual radioactive contamination.

In this paper we review the criteria relevant to free release programs and discuss our situation at Big Rock Point with respect to the potential options for concrete debris from the decommissioning project.

## **PAST PRACTICE AND CURRENT DILEMMA**

In the past, clearance methodologies in the United States have relied primarily on the use of surficial contamination guidelines given in Regulatory Guide 1.86 (1). This guide, which was developed by the Atomic Energy Commission in 1974, provides a Table of Acceptable Surface Contamination Levels for various radionuclides, including natural and enriched uranium, transuranics, and fission products. The guide does not give volumetric contamination guidelines. The surface contamination levels are stated in terms of measurable radioactivity levels but these values are not dose based. The guidance relevant for these is contained in NRC Policy and Guidance Directive FC 83-23 (2). Surficial contamination guidelines have been used for license termination not only for NRC licenses but also in Department of Energy (DOE) projects (3).

For Beta-Gamma emitters (except Sr-90 and others noted in table 1 of Reg. Guide 1.86), the acceptable surface contamination level is 5000 dpm/100cm<sup>2</sup> total, and 1000 dpm 100 cm<sup>2</sup> removable.

A number of regulatory developments have occurred in the past few years and several are in the works. These have significantly altered the criteria for license termination at the decommissioning of a site and may significantly change the criteria for releasing bulk solid materials during decommissioning. The relevant regulatory developments can be grouped in to three areas:

### **(1) License Termination Rule and the Implementation Guidance**

The License Termination Rule, 10 CFR 20 Subpart E, (10 CFR 20.1401-1406), that was published in July 1997 and became applicable to all decommissioning projects in August 1998 after a grandfathering period of one year ended, sets a TEDE limit of 25 mrem/y to an average member of the critical group for unrestricted release of a decommissioned site (4). It also requires the application of ALARA. A regulatory guide (DG-4006) on demonstrating compliance with the rule was published by the NRC as a draft in August 1998 and was open for comments until August 1999 (5). It discusses the release of buildings, soils, and the site, but does not address the release of contaminated equipment or bulk materials such as steel, concrete or demolition debris.

(2) NUREG-1640 and the Dose Based Criteria Development

Since Reg. Guide 1.86 is not dose based and does not provide volumetric guidelines, the NRC has been in the process of developing new methodology to fill this void. The NRC efforts in this area over the past several years have culminated in a comprehensive draft regulatory guide, NUREG-1640, which became available in early 1999 and was open for comments until November 1999 (6). It systematically defines the methodology for clearance and covers both surficial as well as the volumetric guidelines.

The NRC has initiated the rule making process for the release of solid materials at licensed facilities with the publication of an issues paper in Federal Register (7) on June 30, 1999. As a part of the scoping process and to solicit public input, the NRC has just concluded four public workshops, starting with the first one in San Francisco in September 1999, and the last one in Chicago in December 1999 (other two were in Atlanta, Georgia, and Rockville, Maryland).

(3) MARSSIM and the Survey Methodology

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) that was published as NUREG-1575 in December 1997 (8) replaces the final status survey methodology of NUREG/CR-5849. The Final Status Survey (FSS) of the decommissioned site must be conducted in accordance with the MARSSIM methodology.

## **ANSI STANDARD, INTERNATIONAL CRITERIA, AND CRITERIA ASSESSMENT**

### ANSI N13.12

American National Standards Institute (ANSI) approved the ANSI N13.12 standard on August 31, 1999. The standard was developed by the Health Physics Society and it provides both surface and volumetric radioactivity standards for clearance of equipment, materials, and facilities (9). As the NRC has proceeded with its rule making process, it has been suggested by a number of individuals and groups at recent NRC public workshops that NRC should accept this ANSI standard in lieu of the rule making effort. For beta-gamma emitters, selected screening levels from the ANSI standard are quoted in Table 1.

### International Criteria

The international criteria from International Atomic Energy Agency (IAEA) (10) and the European Commission (EC) (11) are essentially dose based at a protection level of 10  $\mu\text{Sv/y}$  (1 mrem/y), even though the derived mass-specific and surface-specific levels may vary in different countries. The amount of activity related to 10  $\mu\text{Sv/y}$  is considered "negligible radioactivity" and it is taken as the criterion for clearance.

The IAEA uses the concept of "exclusion", "exemption" and "clearance". Exclusion covers natural activity sources not amenable to control. Exemption is used for materials outside the regulatory control because of the low risk or because controlling them would be a waste of

resources. Examples of such materials that contain small sources, include consumer products such as smoke detectors and radiotracers used in research. Clearance is used to denote material that has been released from regulatory control. Clearance of materials can be with or without restrictions.

Based on the 10  $\mu$  Sv/y criteria, German Commission on Radiological Protection has recently defined mass -specific and surface -specific clearance levels for solids (12). As an example, such values for selected radionuclides, mentioned earlier, are given here in Table 2 for illustration purposes.

**Table 1 Screening Levels for Clearance (selected from Ref . 9)**

Radionuclide Groups	Screening Levels (S.I. Units)	Surface Screening (Conventional Units)	Volume Screening (Conventional Units)
	(Bq/cm <sup>2</sup> or Bq/g) <sup>(c)</sup>	(dpm/100 cm <sup>2</sup> )	(pCi/g)
<u>Group 2</u> Uranium and Selected High Dose Beta-Gamma Emitters: <sup>22</sup> Na, <sup>54</sup> Mn, <sup>58</sup> Co, <sup>60</sup> Co, <sup>65</sup> Zn, <sup>90</sup> Sr, <sup>94</sup> Nb, <sup>106</sup> Ru, <sup>110m</sup> Ag, <sup>124</sup> Sb, <sup>134</sup> Cs, <sup>137</sup> Cs, <sup>152</sup> Eu, <sup>154</sup> Eu, <sup>192</sup> Ir, <sup>234</sup> U, <sup>235</sup> U, <sup>238</sup> U, Natural Uranium <sup>(e)</sup> , and others <sup>(a)</sup>	1	6,000	30

**Table 2 German Mass- Specific and Surface Clearance Levels for Selected Radionuclides (adapted from ref 12)**

Radionuclide	Mass-specific Unconditional Clearance	Mass-specific Clearance for Disposal	Mass-specific Clearance for Metal Recycle	Surface Contamination Clearance Level Bq/cm <sup>2</sup>
	Bq/g	Bq/g	Bq/g	
Co-60	1E-1	4E+0	6E-1	0.5
Cs-137	5E-1	1E+1	6E-1	0.5
Mn-54	4E-1	1E+1	2E+0	0.5

### Criteria Assessment

From the discussion above it is clear that the European standard is based on the 10  $\mu$ Sv/y (1mrem/y) criteria. By contrast, the NRC guidance has not defined this dose level for clearance. The NUREG 1640 gives dose factors in terms of  $\mu$ Sv/y per Bq/g and  $\mu$ Sv/y per Bq/ cm<sup>2</sup> but does not specify a dose level.

The derived levels also compare inconsistently. For example, considering values for Co-60 (and the dose criteria of  $10 \mu \text{ Sv/y}$ ), while 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 methodology, thus, being 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. As an example, for Co-60, it provides a much more restrictive value of 280 dpm/100  $\text{cm}^2$ , as compared to a value of 5000 dpm/100  $\text{cm}^2$  in the guide. The comparable value in the ANSI N13.12 standard is 6000 dpm/100  $\text{cm}^2$ .

It is clear that nationally and internationally, there are inconsistencies in the release criteria (and the proposed criteria). Given the fact that international commerce involves millions of tons of steel in imports and exports, inconsistencies in standards between nations could lead to major problems in the recycle and reuse of materials. Clearly, there is also a need to harmonize the U.S. standards and methodology with international standards from the IAEA and the EC. In developing a program for the release of equipment, recyclable metal, and concrete from a decommissioning project, these regulatory developments must now be taken into account.

## **BIG ROCK POINT RESTORATION PROJECT**

Consumers Energy is committed to restoring the Big Rock Point 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 future use without any radiological restrictions. Disposition of the demolition debris from the project is being addressed through the Solid Materials Release Program.

The basis of our free release program planning at BRP is the existing guidance from NRC and the recently occurring regulatory developments. However, we have also considered other factors such as the state requirements and the international guidance on the subject.

At the present, the NRC does not have defined environmental release levels for solid effluents as it does for the liquid and gaseous effluents. The NRC is however, in the process of rule making for establishing a methodology for the clearance of solid materials based on the specified dose limits and through the use of exposure pathways analyses.

The new methodology attempts to define both the volumetric as well as the surficial guidelines for residual radioactivity levels. But it is uncertain if the new rule making will be finalized in the next few years.

It should be noted that the license termination of Big Rock Point would be under the License Termination Rule (10 CFR 20.1401-1406) that became effective in July 1997. 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 compliance with the rule is demonstrated through pathways analysis modeling and a Final Status Survey of the site under MARSSIM.

As the decommissioning pace has picked up at BRP, the Radioactive Waste Department has shipped large amounts and complex systems to radioactive waste facility in Barnwell, SC or to GTS Duratek facility in Oak Ridge, TN, for processing and volume reduction. In the past two years, over 2 million lb of material has been shipped as radioactive waste. To date 15 High Integrity Containers (HICs) of resin and 1 high capacity filter HIC, have been shipped to Barnwell. In total, approximately 70,000 Ci have been shipped and disposed of from the Spent Fuel Project and an additional 1,388 Ci have been removed from other parts of the plant and shipped for processing and disposal. It should be noted that it is not viable to treat concrete debris as radioactive waste and ship it for disposal. The residual radioactive contamination on the concrete is very small. About half of the concrete from the foundations below 3 feet depth is non-impacted and clean. The costs of treating such materials as radioactive waste are prohibitive for any decommissioning project. The real difficulty is the requirements of 10 CFR 20 Subpart K, which require a demonstration of licensed material if the material is released from the licensed facility.

### **Options for Bulk Materials**

Bulk materials at BRP that are included in this assessment include concrete debris, roofing materials, and a limited quantity of soils. It is estimated that of the total 84.5 million lb of concrete debris that will originate from the decommissioning project, approximately one half is non-impacted and clean. The other half has residual surface activity and potential activation products in a limited quantity of the bioshield concrete.

Demolition of structures and disposal of concrete rubble are among the final steps in restoring the site to greenfield conditions. There are basically three options.

1. License termination with structures intact

This option will involve removal of licensed radioactive materials from the existing structures to residual radioactivity levels acceptable for termination of the license. Verification of achieving these residual radioactivity levels would require conducting FSS of the remaining structures as well as the site environs. After license termination by NRC, the site would be returned to greenfield conditions by demolishing the remaining structures and disposal of the concrete rubble in a local landfill.

2. Demolition followed by license termination

This option is similar to license termination with structures intact. Removal of licensed radioactive materials from existing structures to residual radioactivity levels acceptable for license termination would still be performed. However, prior to performing the FSS, the remaining structures would be demolished and the concrete rubble left on site. The FSS would then be performed on the site environs. After license termination, the concrete rubble could be used as construction fill or disposed of in a local landfill facility. While this meets all NRC requirements and public health and safety goals, the disadvantages are that the debris is not stabilized in the long-term context. Redevelopment of the site for other uses will also

mean that debris may have to be removed at some later date and relocated to another location on-site or off-site.

3. Demolition and disposal followed by license termination

This option would also involve removal of licensed radioactive materials from the existing structures to residual radioactivity levels acceptable for termination of the license. However, prior to performing the FSS, the remaining structures would be demolished and the concrete rubble disposed of in a local landfill facility. After removal of all demolition debris, the FSS would then be performed on the site environs, the license terminated by the NRC and the site released for unrestricted future use.

The decisions in restoring the site to greenfield conditions are based on what is required by the regulations and what is good for the public health and safety. In addition, it is recognized that given the location of the site on the shores of Lake Michigan, the land is a valuable resource to the company and to the citizens of the area. Hence, option 3 is currently considered the preferred option.

**Assessment of 10 CFR 20.2002 Submission vs. License Amendment Request**

The requirement under 10 CFR Subpart K to demonstrate the absence of licensed material, necessitates that some mechanism, such as the 10 CFR 20.2002 submission or license amendment be used for releasing any solid materials from a licensed facility. The 10 CFR 20.2002 (or 10 CFR 20.302) submissions have been used over the past several years by a number of reactor sites, however, only for small quantities of generally operational wastes and generally for alternate disposal on-site. Such a submission has not been used for a decommissioning project involving much larger quantities of materials. The guidance for preparing 20.2002 submissions is available in NUREG-1101 (13) and other published papers (14).

An alternate approach is a request to NRC for license amendment and establishing Technical Specifications for the release of bulk materials. We believe that either of these approaches is consistent with protecting the public health and safety, keeping any potential exposures to As Low as Reasonably Achievable (ALARA), and restoring the Big Rock Point site to "greenfield" conditions.

Our preliminary analyses have shown that the BRP concrete rubble disposed of and covered in a landfill would lead to a potential dose of less than 1 mrem/y even if very conservative assumptions were made. Even though, the NRC does not have a defined dose limit for solid materials release, it is consistent with their expectations. It is also consistent with the international standards from IAEA and the European Community where a clearance level of 1 mrem/y is used. It should be recognized that the public dose limit is 100 mrem/y and the license termination dose limit is 25 mrem/y. Thus, levels of 1 mrem/y or below are essentially trivial from a perspective of any concerns related to public health and safety.

## BRP Selected Approach

While the structures can be left on-site and included in the final status survey and site license termination, the option that is most attractive is the disposition of demolition debris in a landfill prior to license termination. This is protective of the public health and safety, is consistent with ALARA, and is most cost effective. The criteria used for license termination is 25 mrem/y. In comparison, the dose levels for our submission are typically at or below 1 mrem/y. After an internal analysis of pros and cons, we elected to go with the License Amendment Request. Key elements of our approach are as follows.

- We are planning to submit a license amendment with supporting technical documentation in the form of a Bulk Materials Control Manual (BMCM).
- License amendment route will allow us to establish the Minimum Detectable Activity (MDA) and implement an accept/reject protocol through a bulk monitoring program.
- Establishing an MDA through a Technical Specification change really means that the NRC tells the licensee “how hard to look” for the licensed material.
- Our MDA will be based on a series of analyses including upper bound scenarios and the potential dose to an individual remaining below 1 mrem/y.
- We envision the material flow as shown in Figure 1. The steps include:
  - Remove residual surface radioactivity
  - Survey structures to current NRC surface detectability guidance
  - Demolish structures
  - Bulk assay materials
  - Determine accept/reject status
  - Send to appropriate facility



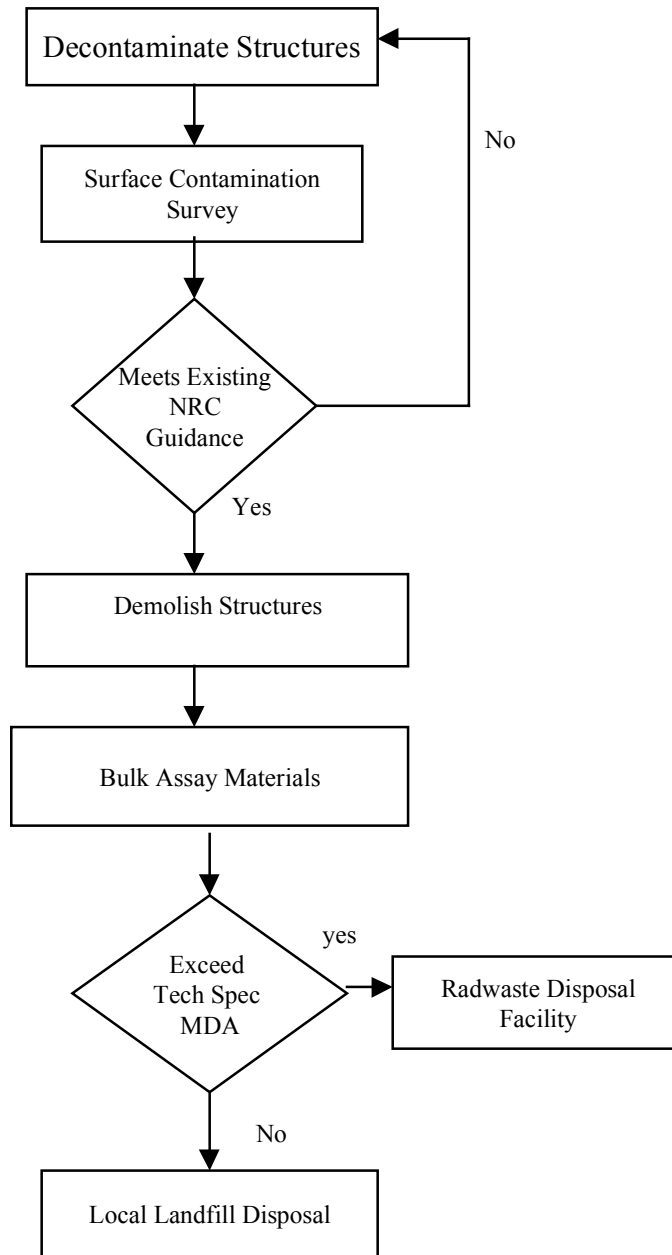


Figure 1 Bulk Materials Flow Diagram

- In our pathway analysis, we plan to use three types of scenarios: truck transport scenario, landfill operator scenario, and the resident/farmer scenario. RESRAD code will be used for the latter two. Transportation assessment may be based on the NUREG-1640 methodology.
- Prior to demolishing structures, criteria for surface contamination will be 5000 dpm/100cm<sup>2</sup> total, and 1000 dpm 100 cm<sup>2</sup> removable. The guidance relevant for these is

contained in Policy and Guidance Directive FC-83-23, IE Circular 81-07 and Information Notice 85-92.

- We plan to dispose of the bulk materials from demolition at a local industrial landfill.

### State Input

We included the state in our discussions early on. In early November 1999, a meeting was held with the state representatives to discuss our plans for this submission to NRC. Even though the State of Michigan is not an Agreement State and the submission will be made to NRC, the NRC will most likely contact the state on this issue and it is imperative to involve the state early on in the process. The concrete debris will go to a local landfill if the NRC approves our submission. Both municipal and industrial landfills have to meet State of Michigan standards, which are strict in their requirements with respect to capping and long-term stability.

Considering the state's position that the landfill space is an important resource, approximately half of the concrete debris that is clean may not need to go to an industrial landfill. Such concrete that can be confirmed as non-impacted could be used in other applications such as building water break wall structures. No decisions have been made as to the disposition of non-impacted concrete.

We have considered the relevant state laws (Michigan Public Acts 434, 435, and Act 113 (and the Amendment, Act 12)). Amendment Act 12 states that no radioactive material may be deposited or stored in this state. Exceptions are possible if a waiver is obtained pursuant to 10 CFR 20.302 (or 10 CFR 20.2002). Such an exception will be necessary for us to proceed with disposal of concrete debris if a 20.2002 submission is applied for and the NRC grants approval. However, from an analysis of pros and cons, as well as, the interface with regulators so far, it is clear that license amendment is the preferred route for BRP. Material below the MDA is considered to be containing no licensed material. From preliminary assessment it is also clear that the MDA will be near 5 pCi/g. For comparison, the State of Michigan limit for NORM (Ra-226) is 50 pCi/g.

State of Michigan has been kept informed of our efforts and the state has indicated its support of our approach.

### Bulk Assay Systems

The Minimum Detectable Activities (MDAs) of bulk assay systems is an important issue. To process such large quantities of materials, BRP is considering designing a system with a release MDA of 5 pCi/g. For comparison purposes only, the state limits for NORM (Naturally Occurring Radioactive Material) is 50 pCi/g. Current environmental release limits at BRP, given in Procedure RM-59, are based on laboratory analysis of samples. These MDA values have been established at 0.15 pCi/g for Cs-137 and 0.13 for Co-60. However, such values are beyond the detection capability of current bulk assay and bulk processing systems.

We have conducted preliminary pathways analysis, which has shown that even for concentrations at the MDA level of the planned bulk assay system, the predicted potential dose to an individual is below 1 mrem/y.

### Submission Schedule and Interface

Current schedule calls for submission of the License Amendment Request and the supporting BMCM to the Nuclear Regulatory Commission by the end of June 2000. We requested and had an information meeting with the NRC on January 18, 2000 at Rockville, MD, and felt that NRC is receptive to this approach. In addition to the NRC staff from Headquarters and Region III, representatives were also present from the EPA, State of Michigan, and an environmental group.

Big Rock Point Restoration Project has ongoing interaction with the Citizens Advisory Board and the public in the area. Public interface on bulk materials release is also being handled through the existing channels.

### **CONCLUSIONS**

In the area of solid materials release from licensed facilities, there are no consensus standards and there is no agreement at the national and international level. The U.S. Nuclear Regulatory Commission currently does not have defined effluent limits for solids as it does for liquid and gaseous materials. The NRC has undertaken rule making for establishing a methodology for the clearance of solid materials but from the public scoping process that just ended in December 1999, all indications are that such a methodology may not become regulation for several years.

For decommissioning projects, which must deal with large quantities of clean or slightly contaminated demolition debris, there are few choices in the regulatory process. The 10 CFR 20 Subpart K requires the demonstration of absence of licensed material. Hence, the only way material can be released from a decommissioning site is through some form of regulatory mechanism such as a 10 CFR 20.2002 submission or a license amendment. An alternate, of course, is to leave the structures or the demolition debris at the site and include it in the license termination and the Final Status Survey under MARSSIM.

At Big Rock Point, we are considering a license amendment request to NRC to establish the MDA for release of bulk materials from this site. Once NRC approval has been granted, we plan to demolish and dispose of the buildings prior to license termination. We believe this route is more protective of the public health and safety in addition to being cost-effective.

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