



POSITION PAPER

# DECOMMISSIONING FUNDING FOR SMALL REACTORS

*October 2010*

### ***ACKNOWLEDGMENT***

This NEI Position Paper was developed by the NEI Small Modular Reactor Licensing Task Force, which includes representatives from designers, utilities, the Electric Power Research Institute, the National Rural Electric Cooperative Association, and the American Nuclear Society's Special Committee on Small and Medium Reactors, the Department of Energy, and the national laboratories.

## DECOMMISSIONING FUNDING FOR SMALL REACTORS

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### I. Summary

The NRC's decommissioning funding regulations and guidance have evolved over the years to provide a robust framework, which ensures that adequate funding will be available to decommission the current generation of large light-water reactors (LWRs) when needed. The current minimum funding requirements are designed to address large, single-unit reactors. The new generation of small reactors<sup>1</sup>, particularly those that will use multi-module installations, will require additional guidance and flexibility to allow decommissioning funding levels to be based on design and site-specific estimates, rather than the funding formulas that are currently used for large LWRs (see 10 C.F.R. § 50.75(c)). Use of design and site-specific cost estimates will be necessary in order to account for the changing nature of the decommissioning funding needs as modules are added to a site over time, and to support multiple decommissioning schedules as older modules are removed from service while those with remaining licensed life continue to operate.

### II. Introduction

The regulations in 10 CFR § 50.75 and associated guidance in Regulatory Guide 1.159, *Assuring the Availability of Funds for Decommissioning Nuclear Reactors* [ref 1], describe how to calculate minimum decommissioning funding amounts for large LWRs, and prescribe the methods that may be used to provide the minimum funding amount.

The process provided in the current regulations has proven effective in a variety of situations and provides a good starting point to address the decommissioning funding needs of small reactors. This paper highlights some issues specific to small reactors, particularly those that use a multi-module design. It is anticipated that the majority of the current regulatory framework will be acceptable, however some changes will be necessary to address the lower decommissioning liability associated with the small reactor designs, as well as phased installation, operation and decommissioning of reactor modules at a common location. The funding mechanisms that are currently used to provide decommissioning funding assurance appear adequate to address the needs of the various ownership structures contemplated for small reactors at this time.

### III. Scope of issues

For a variety of reasons, the formula for calculating the minimum decommissioning funding requirements for large LWRs will need to be revisited for small reactors. The minimum funding amounts for large LWRs are calculated based on historical analysis conducted by Pacific Northwest Laboratory for a reference PWR<sup>2</sup> and reference BWR<sup>3</sup>, for significantly different designs with larger footprints than those applicable to small reactors. These estimates are not synonymous with the decommissioning activities required for small LWRs or the non-LWR designs. First, in the case of modular designs where multiple reactors are installed over time, the

funding profile (i.e. funding as a function of time) will need to reflect the increasing decommissioning funding needs that are incurred as new modules are added. Likewise, the funding profile must account for decreasing funding needs at the end of license life in situations where individual reactor modules experience license expiration at different times and, as a result, are decommissioned or replaced in a sequential manner. Second, small reactors are being designed today to minimize radiological contamination of the facility and the generation of radioactive waste as required by 10 CFR § 20.1406. The purpose of this regulation is to reduce ground water and soil contamination. However this anticipated reduction in decommissioning liability is not reflected in the current minimum decommissioning funding requirements.

Other technical issues will arise on a design-specific basis, such as the possibility that reactor modules could be removed from the site and decommissioned at an alternate location. In addition, the balance of plant structure may not be a traditional electricity generation model, but could involve the production of process heat or a combination of industrial processes. As a result, decommissioning of small reactors may involve equipment that differs from the balance of plant equipment traditionally addressed during the decommissioning of large LWRs used in electric generation and analyzed in the development of current decommissioning requirements.

NRC staff provides a similar description of the decommissioning funding issue for small reactors in SECY-10-0034, *Potential Policy, Licensing, and Key Technical Issues for Small Modular Nuclear Reactor Designs* [ref 2]. In item 5.3 (of the attachment to SECY-10-0034), the staff recognized that the formulas provided in 10 C.F.R. 50.75 do not apply to non-LWR designs and suggested a revised approach involving consideration of design-specific cost estimates for non-LWR designs. The staff also expressed a willingness to consider design-specific cost estimates for certain LWR designs, provided an adequate justification is provided. To address these issues, this position paper includes review of existing regulations and guidance to determine whether any changes to requirements are essential or advisable. Actual estimates of decommissioning liabilities will have to be determined on a design-specific basis.

Table 1 identifies a number of potential issues where regulatory flexibility would be beneficial. As small reactors can be deployed in different scenarios, the entries in Table 1 have been grouped by reactor type and siting considerations.

Reactor Type	Siting	Issues
Small LWR	Single unit	<ul style="list-style-type: none"> <li>• Need exemption from current minimum funding level required for large LWR to allow for design-specific decommissioning funding estimate.</li> </ul>
Small LWR	Multiple modules	<ul style="list-style-type: none"> <li>• Need exemption from current minimum funding levels designed for large LWR to allow for design-specific decommissioning funding estimate.</li> <li>• Funding requirements should be specifically timed with the start-up of additional modules</li> <li>• Interim removal strategies for modules reaching the end of licensed life should be incorporated</li> </ul>
Non-LWR	Single unit	<ul style="list-style-type: none"> <li>• Requires design-specific decommissioning funding estimate</li> </ul>
Non-LWR	Multiple modules	<ul style="list-style-type: none"> <li>• Requires design-specific decommissioning funding estimate</li> <li>• Funding requirements should be specifically timed with the start-up of additional modules</li> <li>• Interim removal strategies for modules reaching the end of licensed life should be incorporated</li> </ul>

**Table 1. Range of Reactor Design and Siting Issues Associated with Small Reactor Decommissioning Funding Estimates**

#### **IV. Current regulatory framework**

10 CFR § 50.75 in combination with § 50.33(k) provides the regulatory framework for decommissioning funding assurance. These regulations require that power reactor licensees evaluate the adequacy of their decommissioning funds periodically during the lifetime of the reactor. Specifically, power reactor licensees are required to recalculate the required minimum amount of decommissioning funding annually using the adjustment factors provided in 10 C.F.R. §50.75(c), and to submit reports describing the status of their decommissioning funds biennially. In addition, more specific estimates of the amount that will be required to decommission the reactor must be provided as the reactor approaches the end of its licensed operating life. This framework provides assurance that decommissioning funding obligations will be met, thereby ensuring that public health and safety is protected and unnecessary decommissioning delays are avoided.

Regulatory Guide 1.159, provides further details on the methodology for calculating minimum decommissioning funding amounts and describes acceptable funding mechanisms that can be

used by applicants and licensees to cover those amounts. The focus of both the regulations and the regulatory guide is on large LWRs. There are some allowances and guidance for research reactors and fuel cycle facilities, but small single or multi-module reactors are not specifically contemplated in the current guidance.

The Commission has reviewed issues related to small reactors several times over the past decade. For example, SECY-01-0207, *Legal and Financial Issues Related to Exelon's Pebble Bed Modular Reactor (PBMR)* [ref 3], describes NRC's positions relative to a number of legal and financial issues raised by Exelon (PBMR). In Issue F, "Can a PBMR licensee submit decommissioning cost estimates specifically for a PBMR and on a per module basis?" the NRC discussed Exelon's proposal to use a site-specific cost estimate for PBMR decommissioning. In that case, the NRC considered the Exelon approach to be reasonable.

SECY-02-0180, *Legal and Financial Policy Issues Associated with Licensing New Nuclear Power Plants* [ref 4], discussed decommissioning funding issues similar to those discussed in SECY-01-0207. Specifically, in addressing Issue F the staff stated that it would be willing to accept design-specific minimum funding estimates for non-LWRs (speaking to the gas reactor designs, PBMR and GT-MHR) if an acceptable technical justification was provided. For modular facilities, the staff also noted that a design-specific estimate could be made for a single module, and then replicated to cover new modules as they are added. Alternatively, the minimum estimate could capture multiple modules in the base case, as discussed in this excerpt from SECY-02-0180:

*The staff is willing to accept a design-specific minimum decommissioning cost estimate for non-LWR designs if the staff finds the technical justification to be acceptable. For a modular facility, the staff is willing to review a standard decommissioning cost estimate based on the decommissioning of one module, which can then be applied multiple times for the facility in question, or (alternatively), a cost estimate based on the decommissioning of multiple modules at a single location. Regardless of the method used, the resulting estimate must include the cost of decommissioning common elements and structures associated with the facility, in addition to the costs of decommissioning each individual module.*

SECY-02-0180 (Issue H) also discusses the number and conduct of reviews for multiple, standardized modules. In its discussion of Issue H, the staff addressed the start of a license life and the duration of a license (for modules), but did not address the end of life issues associated with phased decommissioning.

As described earlier, SECY-10-0034 (Item 5.3) describes NRC's current thinking on how a non-LWR applicant could establish a decommissioning cost estimate, including the impact of multiple modules on a single site. As with SECY-02-0180, the NRC stated that while the formulas in 50.75(c) do not apply to non-LWR designs, an applicant could submit a minimum decommissioning estimate based on a site-specific analysis (rather than the generic LWR model). Design specific estimates were considered appropriate. Also, as with SECY-02-0180, for modules, the NRC stated an applicant might present its estimate for one module and then

apply the estimate multiple times for following modules. Alternatively, an applicant could provide an estimate for multiple modules as its base case.

The relationship between modular construction and the timing of decommissioning liabilities was addressed by the Commission during its review of the application for the Louisiana Energy Services gaseous centrifuge enrichment facility in Eunice, New Mexico. This facility has a limited number of modules operating while construction continues on additional modules today as part of a combined license. In NUREG-1827, *Safety Evaluation Report for the National Enrichment Facility in Lea County, New Mexico* [ref 5], the NRC approved a method for addressing the changing liability associated with the timing of additional modules on page 10-14:

*Subsequent updated decommissioning funding estimates and revised funding instruments for facility decommissioning will be provided at least every three years. If the applicant reduces the amount of funding for the facility because of a change in module phase-in, the revisions will be submitted prior to the operation of each facility module. This will allow the applicant to modify its initial facility decommissioning funding approach to reflect changes in future enrichment module phase-in schedules.*

In addition to specific guidance regarding funding assurance requirements, in August 2007 the NRC expanded its rule requiring that applicants for licenses describe how radiological contamination will be minimized through facility design and operating procedures (10 CFR § 20.1406). This rule requires applicants to describe design and operational measures that will minimize radiological contamination, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste. There are several measures available to implement the rule, all of which will ensure that best practices are observed to minimize future decommissioning liabilities. Implementation of the modified rule and associated guidance, which should result in even lower decommissioning costs for small reactors, has not been factored into any of the minimum funding formulas for power reactors.

## **V. Recommended regulatory framework for SMRs**

The current regulatory framework as described in 10 CFR § 50.75 in combination with § 50.33(k) and explained in detail in Regulatory Guide 1.159 provides a number of different options for funding mechanisms to demonstrate reasonable assurance of decommissioning funding at the end of facility life. These funding mechanisms appear adequate, given the ownership structures that are currently envisioned for small reactors. No changes will be necessary to this portion of the regulatory framework.

However, the current regulatory framework does not mention non-LWR reactors and it is clear that the formulas provided in 10 CFR § 50.75(c) do not apply to non-LWR designs. The staff is clearly open to providing design and site-specific estimates for non-LWR designs, as illustrated by the SECY papers described above. This position should be further described and documented in NRC guidance as an acceptable method of calculating the minimum decommissioning funding liability for non-LWR designs. The current guidance for creating estimates (costs associated with labor, energy, and disposal) should provide enough information and flexibility to allow an

applicant to create a design-specific estimate using the existing tools in 10 CFR § 50.75 and further described in NUREG-1307, *Report on Waste Burial Charges: Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities* [ref 6].

Small LWR designs will require an exemption to 10 CFR § 50.75(b) in order to rely on design-specific decommissioning funding estimates that are lower than the amount derived using the standard formulas provided in the regulations. For the reasons described above, this is an appropriate path that would better reflect the actual decommissioning funding amounts required to provide reasonable decommissioning funding assurance for new reactor designs, which incorporate many modern features and lessons learned to minimize the expense of decommissioning. The issuance of exemptions to 10 CFR § 50.75 is a reasonable approach for near-term license applicants, given the variation in design and siting considerations that will likely exist in the initial wave of small LWR license applications. In the future, as the NRC staff and applicants accumulate experience in developing site and design-specific decommissioning cost estimates for small LWRs, it may be beneficial to update the rule language to create a new category for small LWR designs.

The staff position in NUREG-1827 provides an example of a path forward for timing of the liabilities associated with multi-module facilities. The regulations and current guidance do not contemplate this issue. It is anticipated that a future revision to Regulatory Guide 1.159 could provide specific guidance on how to address the need to provide additional funding associated with future modules. Proposed changes to the language in Regulatory Guide 1.159 are presented in the Appendix. The current requirements require decommissioning funding assurance mechanisms to be in place prior to the initial fuel load. A recommended approach to multi-module facilities would require the funding assurance mechanism(s) to be updated to provide funding for liabilities associated with the additional modules as fuel load commences in each new module.

Current regulations provided in 10 CFR § 50.82 and associated guidance contemplates only full site remediation at the end of reactor life and do not provide for use of the decommissioning trust for partial decommissioning while the facility continues to operate. Although this issue is in the distant future, with multi-module facilities, individual modules could have sequential license termination dates. It is envisioned that the owner/operator may wish to decommission a spent module at the end of its life even if others are still in operation. Updates to the rule language and guidance would likely be necessary to provide a mechanism for use of decommissioning trusts for partial facility decommissioning in this instance.

## **VI. Conclusion**

The framework provided in 10 CFR § 50.75 ensures that adequate decommissioning funding assurance will be provided for nuclear reactors. The financial mechanisms described in the regulations and associated regulatory guidance (e.g., Regulatory Guide 1.159) is adequate in the near-term to address the liabilities and ownership structures contemplated by the current small reactor designs.

NEI believes the challenges associated with decommissioning assurance for small reactors are confined to the need for site and/or design-specific estimates, and additional flexibility associated with the timing of module operation as contemplated by multi-module design. The NRC has addressed both of these issues in the past and there appears to be a reasonable path forward based on revisions to existing guidance and, in the case of small LWR designs, exemptions from the standard minimum formula amounts for decommissioning funding provided in the regulations. NEI urges the Staff to make the proposed changes to Regulatory Guide 1.159 found in the Appendix to this paper.

## **VII. References**

1. U.S. Nuclear Regulatory Commission, *Assuring the Availability of Funds for Decommissioning Nuclear Reactors*, Regulatory Guide 1.159, Revision 1, October 2003.
2. U.S. Nuclear Regulatory Commission, *Potential Policy, Licensing, and Key Technical Issues for Small Modular Nuclear Reactor Designs*, SECY 10-0034, March 28, 2010.
3. U.S. Nuclear Regulatory Commission, *Legal and Financial Issues Related to Exelon's Pebble Bed Modular Reactor (PBMR)*, SECY 01-0207, November 20, 2001.
4. U.S. Nuclear Regulatory Commission, *Legal and Financial Policy Issues Associated with Licensing New Nuclear Power Plants*, SECY 02-0180, March 7, 2002 (and SRM dated March 31, 2003).
5. U.S. Nuclear Regulatory Commission, *Safety Evaluation Report for the National Enrichment Facility in Lea County, New Mexico, Louisiana Energy Services*, NUREG-1827, June 2005.
6. U.S. Nuclear Regulatory Commission, *Report on Waste Burial Charges: Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities*, NUREG-1307, Revision 13, November 2008.

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## APPENDIX

### PROPOSED CHANGES TO REGULATORY GUIDE 1.159

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Proposed changes to Regulatory Guide 1.159 are provided below as indicated by underlined text.

Section B, Discussion, under the heading “Amount of Funds for Decommissioning” at the bottom of page 1.159-2:

a. An initial certification amount (or, for non-power reactors or non-light-water reactors, a site-specific estimate) established at the operating license stage (for existing licensees, by July 26, 1990). (10 CFR §§ 50.75(b) and 50.75(c)(1)). For small light-water reactors, an exemption may be requested to provide a site-specific estimate that is potentially less than the standard formulas that are designed for large light-water reactor designs.

Section 1.1.1 first paragraph, page 1.159-6:

For large light-water power reactor applicants and licensees, the initial certification amount of funds for decommissioning is based on the equations in 10 CFR § 50.75(c)(1) and represents the minimum funding level that applicants and licensees must meet. Small light-water reactor applicants may request an exemption to provide a site-specific estimate that is potentially less than the standard formulas that are designed for large light-water reactor designs.

Section 1.1.2 title and first paragraph, page 1.159-6:

#### **1.1.2 Non-Power and Non-Light-Water Reactor Applicants and Licensees**

For non-power and non-light-water reactor applicants and licensees, the amount of funds is to be based on a cost estimate for decommissioning the facility and submitted to the NRC in a report required by 10 CFR §50.33(k). The cost estimate for decommissioning need not be an exact accounting of the actual cost of decommissioning, but rather an estimate of the costs for decommissioning the reactor. The PNL studies (Ref. 1) may be used by applicants or licensees for initial cost estimates with suitable adjustments to account for the facility-specific differences as discussed in Regulatory Positions 1.4.2 and 1.4.3. The level of detail necessary to support the cost estimate is discussed in Regulatory Position 1.3.

Add a new section 1.4.4, Page 1.159-10

#### **1.4.4 Special Considerations for Multi-Module Reactor Installations**

For LWR and non-LWR plant designs that include multiple reactor modules, the cost estimate may increase or decline based on the number of installed modules. The licensee will provide a design-specific estimate for the base infrastructure and an estimate for the addition of individual reactor modules. The initial estimate will include site infrastructure and the initial reactor module(s) proposed for installation. Subsequent reactor module installation will require decommissioning funding assurance mechanisms to be in place for the additional module(s) prior to fuel load. Likewise, the total site liability could be decreased if an individual reactor module(s) is decommissioned and decontaminated prior to the termination of operation of other reactor modules at the site.

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<sup>1</sup> Small reactors are defined as the class of reactor having a licensed thermal power rating less than or equal to 1,000 MWt.

<sup>2</sup> NUREG/CR-0130, Addendum 4, Konzek, G. J., and R. I. Smith, *Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station – Technical Support for Decommissioning Matters Related to Preparation of the Final Decommissioning Rule*, prepared by Pacific Northwest Laboratory, Richland, Washington, for U.S. Nuclear Regulatory Commission, July 1988.

<sup>3</sup> NUREG/CR-0672, Addendum 3, Konzek, G. J., and R. I. Smith, *Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station - Technical Support for Decommissioning Matters Related to Preparation of the Final Decommissioning Rule*, prepared by Pacific Northwest Laboratory, Richland, Washington, for U.S. Nuclear Regulatory Commission, July 1988.