

Single vs. Multi-Module Design Certification

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Meeting Approach

- **Issue definition and outcome objectives as described at 1st planning meeting**
- **Modular certification considerations**
- **Exelon RAIs approach**
- **Next steps**



Issue Definition

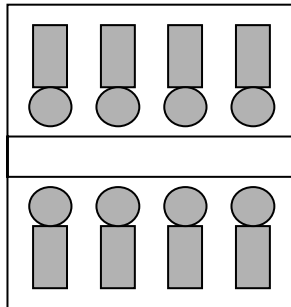
- **Background**

- PBMR's standard design can be implemented in various module configurations. It would require considerable NRC and industry resources to certify different combinations that could be of interest to owners.
- Proposed revisions to the Price Anderson Act recognize that small, modular reactors present a different circumstance than large LWR designs.
- The issue for PBMR is how best to address the Part 52 requirements for an applicant seeking certification of a truly modular design.

- **Issue**

- Determine whether it is feasible to obtain a Design Certification on a single PBMR reactor module and have that certification apply to any subsequent combination of modules

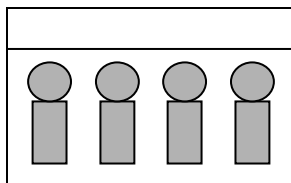
Flexible Plant Configurations



8-pack configuration

8 x 165 MWe

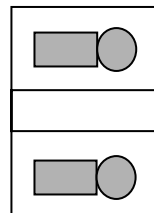
Total output 1320 MWe



4-pack configuration

4 x 165 MWe

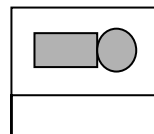
Total output 660 MWe



2-pack configuration

2 x 165 MWe

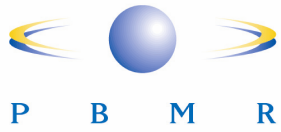
Total output 330 MWe



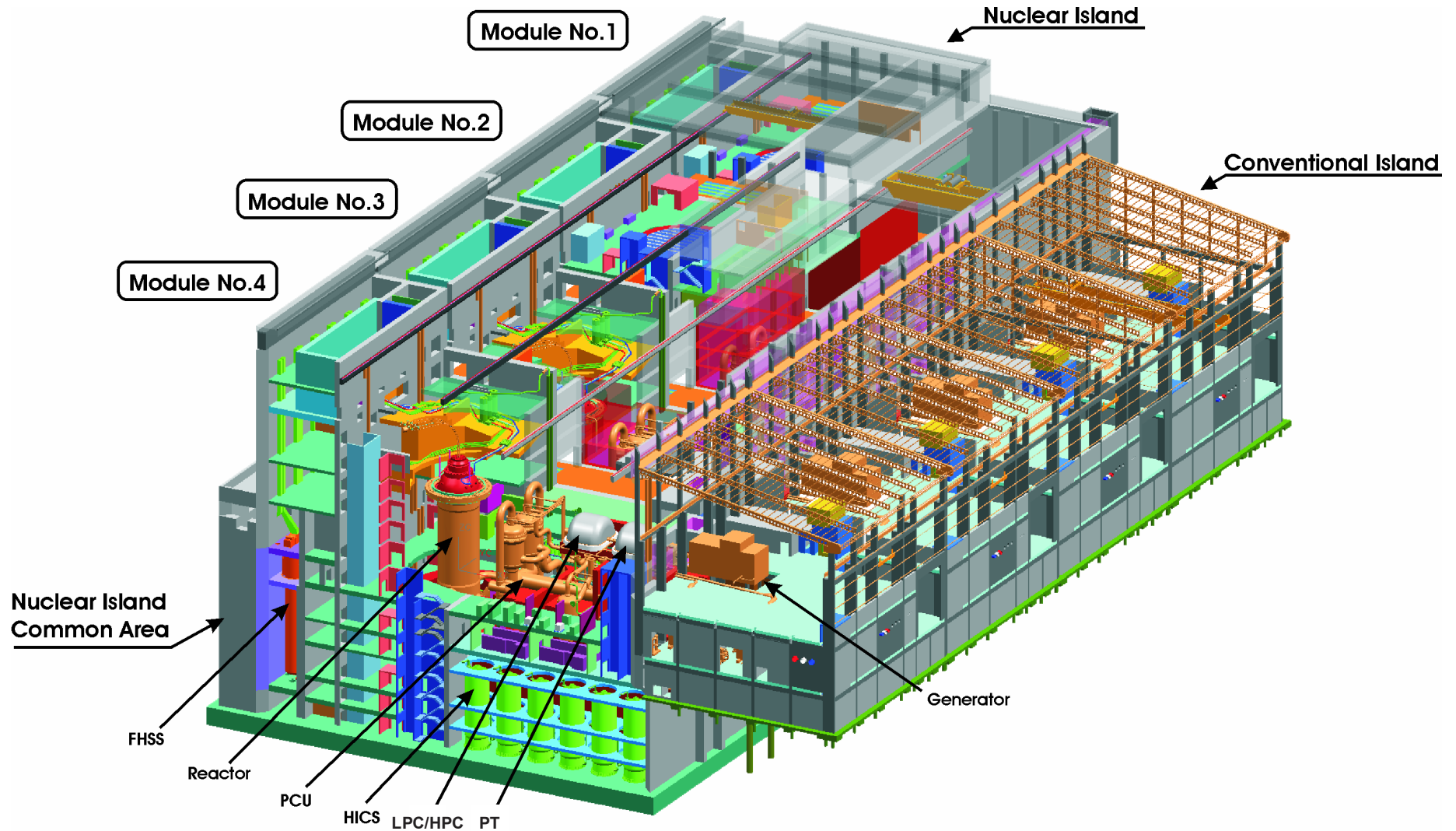
Standalone configuration

1 x 165 MWe

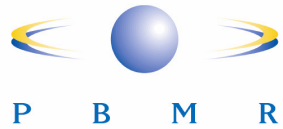
Total output 165 MWe



Multi-Module Plant (4-pack)



- **Issues with Multi-Module certification include**
 - Establishment of a basic module configuration for the design that allows for variations in, or sharing of, common systems
 - Determination of the extent to which design certification safety analyses must include events affecting more than one reactor module
 - Specification of boundary conditions between modules such that safety considerations may be developed at the module level
 - Specification of interface requirements between reactor modules
 - *Level of detail*
 - *Balance between DC and COL applications*
 - Identification of restrictions which may be necessary during the construction and startup of a given module to ensure the safe operation of any module already operating



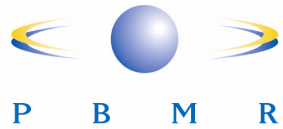
Outcome Objectives

- **Agreement on approach**
 - The fundamental safety case is based on a single module.
 - Interface requirements are specified for systems that are wholly or partially outside the scope of the PBMR basic module that assure that module safety is maintained.
 - Shared systems, common cause failures, and systems interactions are verified during COL review.
- **Understanding on level of detail needed to describe the various options for the configuration of the design, including variations in, or sharing of, common systems**

Requirements - Technical

Requirement	Focus	Implementation
52.47(b)(3)	module(s) under construction	<p>Description of various module configurations, including variations in, or sharing of, common systems, interface requirements, and system interactions</p> <p>Restrictions during construction / startup</p>
50.34(b)(6)(vii)	operating module(s)	<p>Evaluation of potential hazards to SSCs</p> <p>Administrative controls during operation</p>
GDC 5	sharing of SSCs	<p>Demonstrate that sharing:</p> <ul style="list-style-type: none"> • will not significantly impair SSCs ability to perform safety functions • will not prevent orderly shutdown of remaining module(s)

- **10 CFR 52.47(b)(3)**
 - An application seeking certification of a modular design must describe the various options for the configuration of the plant and site, including variations in, or sharing of, common systems, interface requirements, and system interactions. The final safety analysis and the probabilistic risk assessment should also account for differences among the various options, including any restrictions which will be necessary during the construction and startup of a given module to ensure the safe operation of any module already operating.
- **10 CFR 50.34(b)(6)(vii)**
 - On or after February 5, 1979, applicants who apply for operating licenses for nuclear power plants to be operated on multiunit sites shall include an evaluation of the potential hazards to the structures, systems, and components important to safety of operating units resulting from construction activities, as well as a description of the managerial and administrative controls to be used to provide assurance that the limiting conditions for operation are not exceeded as a result of construction activities at the multiunit sites.
- **GDC 5**
 - *Sharing of structures, systems, and components.* Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.



Basic Premise Is Accepted

- **Price Anderson Act recognizes modular reactors as a potential configuration in the future.**
- **10 CFR recognizes several different attributes of small, modular reactors and how to treat them.**
- **Large LWR plants have been designed and licensed with shared SSC, including control rooms.**
- **Therefore, there is already some basis for policy acceptance of now using Part 52 to certify the basic safety of a single module.**



Price-Anderson Act Amendments

SEC. 608. TREATMENT OF MODULAR REACTORS.*

Section 170 b. of the Atomic Energy Act of 1954 (42 U.S.C. 2210(b)) is amended by adding at the end the following:

“(5)(A) For purposes of this section only, the Commission shall consider a combination of facilities described in subparagraph (B) to be a single facility having a rated capacity of 100,000 electrical kilowatts or more.

(B) A combination of facilities referred to in subparagraph (A) is two or more facilities located at a single site, each of which has a rated capacity of 100,000 electrical kilowatts or more but not more than 300,000 electrical kilowatts, with a combined rated capacity of not more than 1,300,000 electrical kilowatts.”

*Energy Policy Act of 2005

- **Extent of safety analyses to be performed**
 - Demonstration of single module safety
 - System interactions
 - Integrated risk
 - Site envelope
- **Level-of-detail to be included in DCD**
 - Tier 1 / 2 content
 - COL applicant interfaces
- **Construction issues**

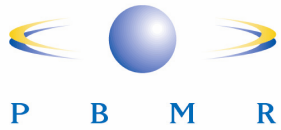
- **DCD Tier 1 / 2 Information**

- Compliance with Tier 1 is mandatory.
- Compliance with Tier 2 is required but changes to or plant-specific departures from Tier 2 are permitted (governed by the DC Rule).

- **COL Applicant Interfaces**

- ITAAC (DCD Tier 1)
- Compliance with site parameters and interface requirements (DC Rule IV.A.2.d)
- Addressing COL Action Items (DC Rule IV.A.2.e)

- **Quality of construction**
 - Use of a standard design
 - High level-of-design completed
 - System modules fabricated in factory
- **Operational impacts**
 - Sequestration of operating unit(s)
 - Impact on unit(s) under construction from operations



Exelon RAIs

Area of Review	Timing	Pre-application Work Item(s)
<i>White Papers</i>		
Modular Component Fabrication		
RAI 3.2.9	2	
Electrical and I&C		
RAI 3.2.24	2	
<i>Licensing Approach</i>		
Number of Modules / Site		
RAI 5.2	1	

- **The following are proposed work items:**
 - White Papers on the legal basis for single module certification; proposed module boundary conditions for DCA analysis; conditions for shared systems analysis; analytical approach for integrated plant risk for maximum number of modules covered by the certification; proposed boundary conditions for concurrent construction and operations
 - Workshop to discuss white papers and outcomes; propose DCA specification on this topic
 - NRC review and provide RAI's
 - Workshop to preview/discuss RAI responses
 - Revise white papers and resubmit for NRC final consideration
 - NRC complete topic analysis to reach closure