



Analysis and Design of Innovative Structures

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Purpose

- Present staff's views and review approach regarding innovative nuclear reactor structures for which existing Codes and Standards are not (explicitly) applicable



Agenda

- Staff Views/Expectations
- Review Approach
- Definitions
- Current Design Applications
- Design/Analysis Process
- Design Considerations
- Analysis Considerations
- Conclusions



Staff Views/Expectations

- Staff encourages innovative designs
- New designs for innovative structures must satisfy regulations
- Staff expects designs to be based on sound engineering principles and validated methods



Review Approach

Regulations

- Existing Nuclear Power Plant fleet designed in compliance with the regulations:
 - GDC 1: Quality standards and records
 - GDC 2: Design bases for Protection against natural phenomena
- New designs for innovative structures must satisfy the above regulations
- Lack of applicable codes and standards will result in more effort to demonstrate compliance with the regulations

Review Guidance

Standard Review Plan framework is applicable to innovative structures



Definitions

- Innovative Structures - New types of structures in nuclear power plant construction
- Design - to establish a structure that will meet performance criteria commensurate with the importance of the safety functions of the structure
- Analysis - to predict the behavior of a structure under loads with mathematical models

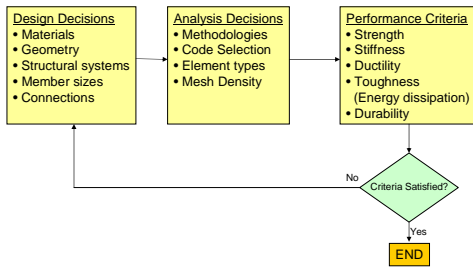


Current Standardized Design Certification Applications

- New construction techniques used:
 - Concrete filled between steel plates (SC)
- AP1000
 - Containment Internal Structures
 - Auxiliary Building
 - Shield Building
- USAPWR
 - Containment Internal Structures



Design/Analysis Process





Design Considerations

- Avoid Irregularities**
- Avoid abrupt changes in mass, strength, stiffness, and ductility
 - Avoid load path discontinuity
 - Avoid eccentricity (center of mass vs. center of resistance) - torsion
- Understand Building Codes' Requirements and Insights**
- Provide adequate strength and stiffness
 - Provide ductility and toughness for seismic resisting systems commensurate with the importance of the safety functions to be performed by different levels of design and detailing
 - Provide durability: use proper materials, minimize concrete cracking, and prevent steel and rebar from corrosion
- Consider Constructability**
- Consider Inspectability**



Analysis Considerations

- **Use Appropriate Analysis Methods**
 - Understand applicability and limitations of methods
 - Validate methods through testing/benchmarking
 - Evaluate and interpret analysis results for their adequacy



Conclusions

- New and innovative design is encouraged
- New designs for innovative structures must satisfy regulations
- Design should be based on sound engineering principles and validated methods
- Lateral (earthquake or wind) load resisting systems, load paths, and connection details should be considered early in the design
- Environmental effects such as thermal, fatigue, and construction loads, should also be considered early in the design
