Surry Power Station
New Fuel Storage and Spent Fuel Pool
Criticality Analysis
Proposed License Amendment Request

NRC Pre-Submittal Meeting

May 13, 2021

Nuclear Engineering and Fuel

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Agenda

- Current Surry SFP Configuration
- Proposed Changes
- Analysis Methods
- Conservatism
- Conclusion/Timeline
- Criticality Analysis Checklist

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Current Spent Fuel Pool Configuration

- One rack design, 2 regions
  - Maximum fuel enrichment: 4.3 wt. % U-235
  - Racks have a large cell pitch (14 inch pitch)
  - No neutron absorber material
  - Region 1
    - 4-out-of-4 pattern with burnup credit
    - Susceptible to cask drop accident
  - Region 2
    - 4-out-of-4 pattern with no burnup credit

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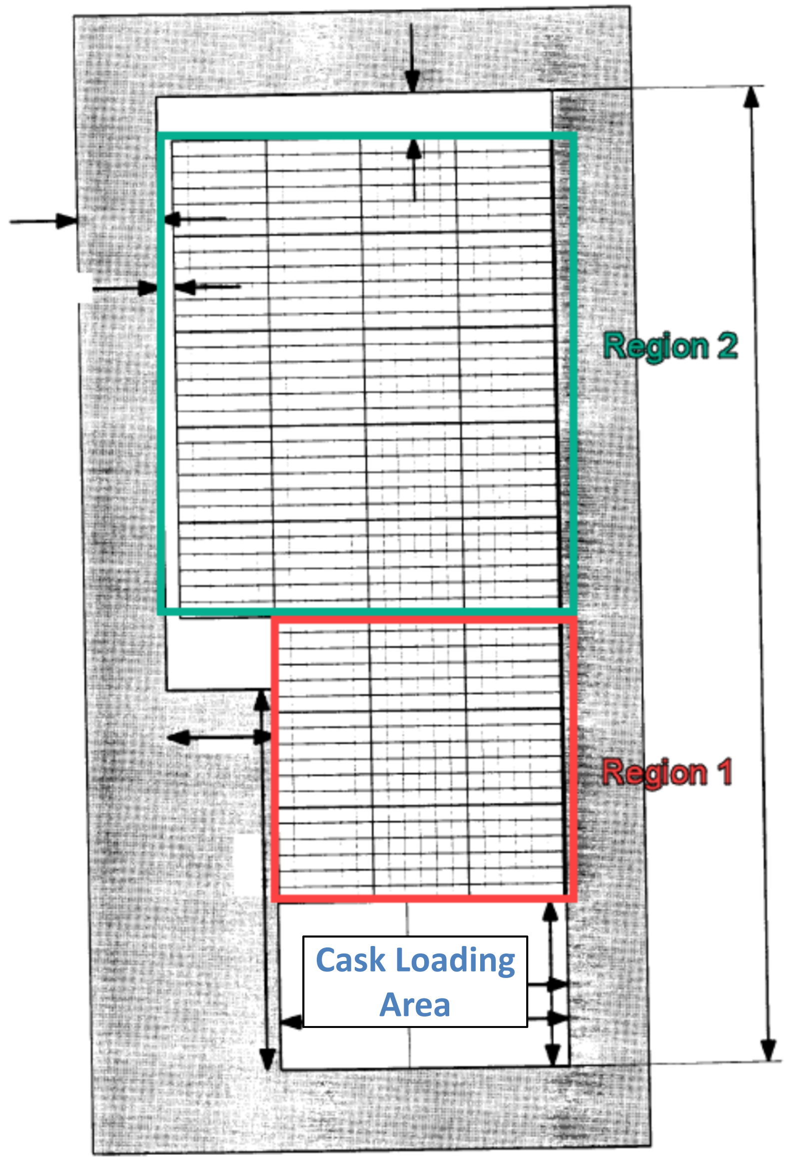
Current Spent Fuel Pool Configuration



Current Spent Fuel Pool Configuration

- SFP boron concentration $\geq$ 2300 ppm
  - Technical Specification limit
  - Boron credited only for accident conditions
    (No dilution accident analysis. $k_{eff} \leq 0.95$ with unborated water)

Proposed SFP Changes and Goals

- Increase maximum enrichment to 5.00wt%
- Update analysis
  - Includes items identified in Reg Guide 1.240 (NEI 12-16)
  - Brings analysis and codes in-house
- Add soluble boron credit for normal and accident conditions
  - $k_{eff} \leq 1.00$ when flooded with unborated water
  - Introduces boron dilution analysis
  - Maintains SFP Tech Spec minimum soluble boron (2300 ppm)
- Add gadolinium burnable absorber into the Licensing Basis
  - Added to code benchmarking analysis and explicitly modeled in depletion
- Increase identified analysis margin
  - NRC and Dominion Energy margin partitioned

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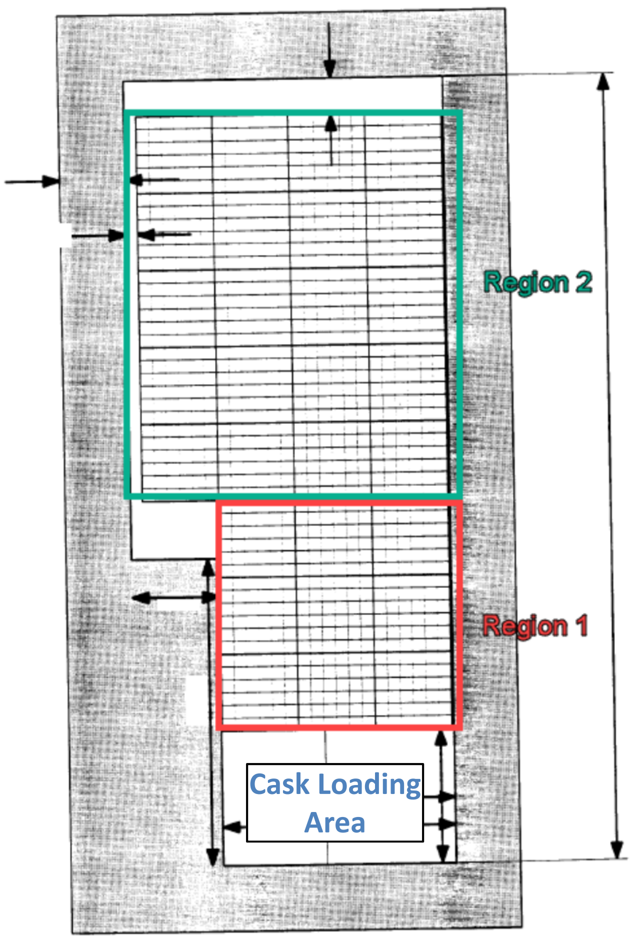
Proposed SFP Changes and Goals



- Maintain the 2 region configuration
  - Region 1: 4 out of 4 with updated burnup curve
  - Region 2: 4 out of 4 without burnup curve

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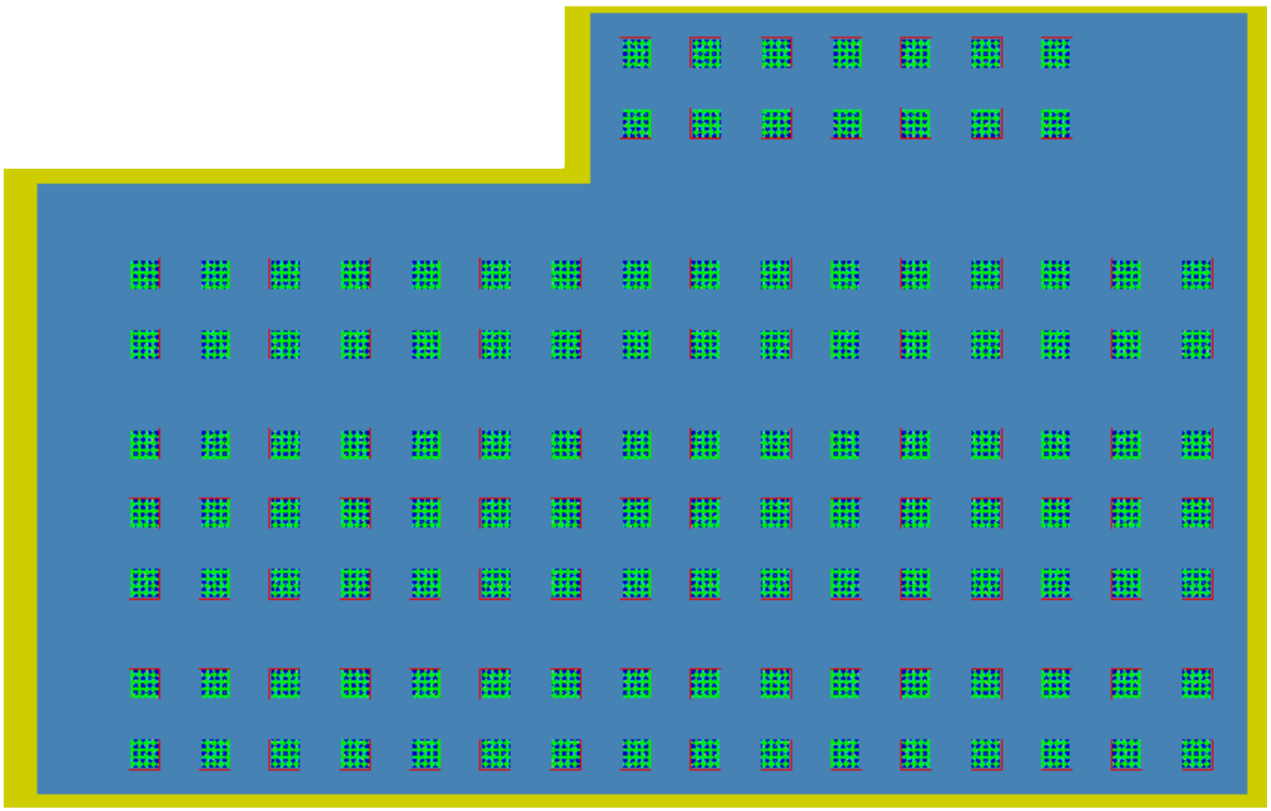
Current New Fuel Storage Area Configuration

- Maximum fuel enrichment: 4.3 wt. % U-235
- No empty cells required or burnable absorber credited



Proposed New Fuel Storage Area Changes and Goals

- Two storage configuration options
  - All cells used when all fuel is enriched to ≤4.35wt%
  - Required empty cells when any fuel is enriched to >4.35wt% (3-out-of-4 storage geometry)
- Update analysis
  - Includes items identified in Reg Guide 1.240 (NEI 12-16)
  - Same computer codes as SFP analysis
- Increase identified analysis margin
  - NRC and Dominion Energy margin partitioned

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Proposed New Fuel Storage Area Changes and Goals

- 3 out of 4 Configuration ("X" locations are required to be empty)

Analysis Methods

- SCALE 6.2.3 with ENDF/B-VII 238 group cross section data
  - KENO-V.a criticality calculation
  - TRITON / T5-depl (KENO-V.a) fuel depletion
  - ORIGAMI fuel decay
  - New code benchmarking analyses
    - NUREG/CR-6698 used for criticality code analysis
    - EPRI Benchmark and Utilization Reports used for depletion code analysis
- Consistent with RG 1.240 (NEI 12-16)

Analysis Methods

- Boron dilution analysis
  - Supports incorporation of soluble boron credit
  - Identifies water sources, flow rates and volumes
  - Calculates dilution times
  - Discusses means of detection and mitigation
  - Starting and ending soluble boron conservatively bounded by criticality analysis boron
    - Boron required for normal storage ≥ 350 ppm
    - Technical Specification boron ≥ 2300 ppm

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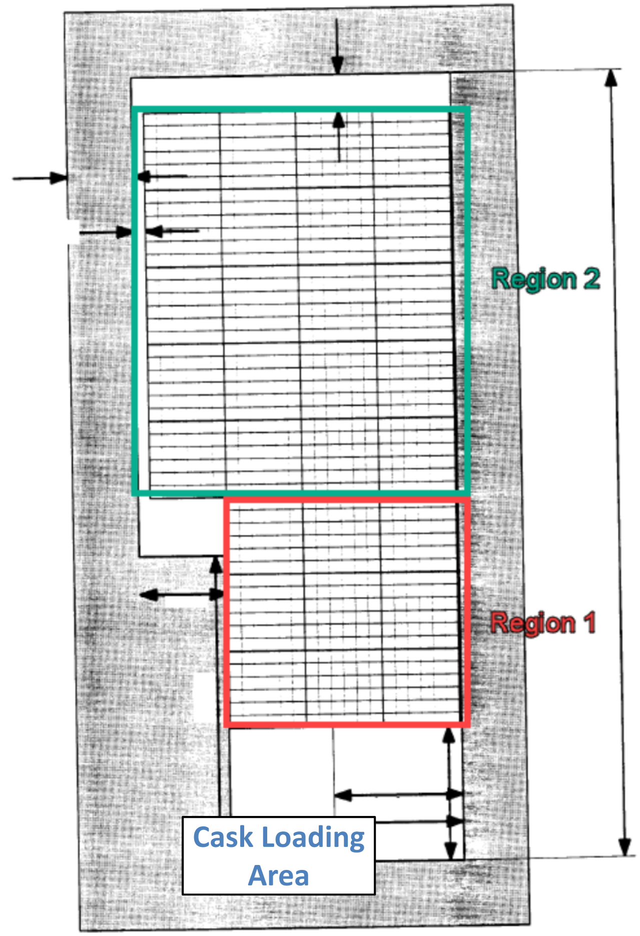
Cask Drop Accident

- Cask Drop Accident
  - No wall between the cask loading area and fuel racks
  - Assumes cask is dropped and tips over.
  - Mechanical analysis shows two rows of 6x6 rack modules will be damaged.
  - The current Analysis of Record:
    - CSA conservatively assumes 3 rows of rack modules are damaged
    - CSA assumes racks are deformed to optimum pitch
  - New CSA additionally assumes fuel pins are deformed to optimum pitch



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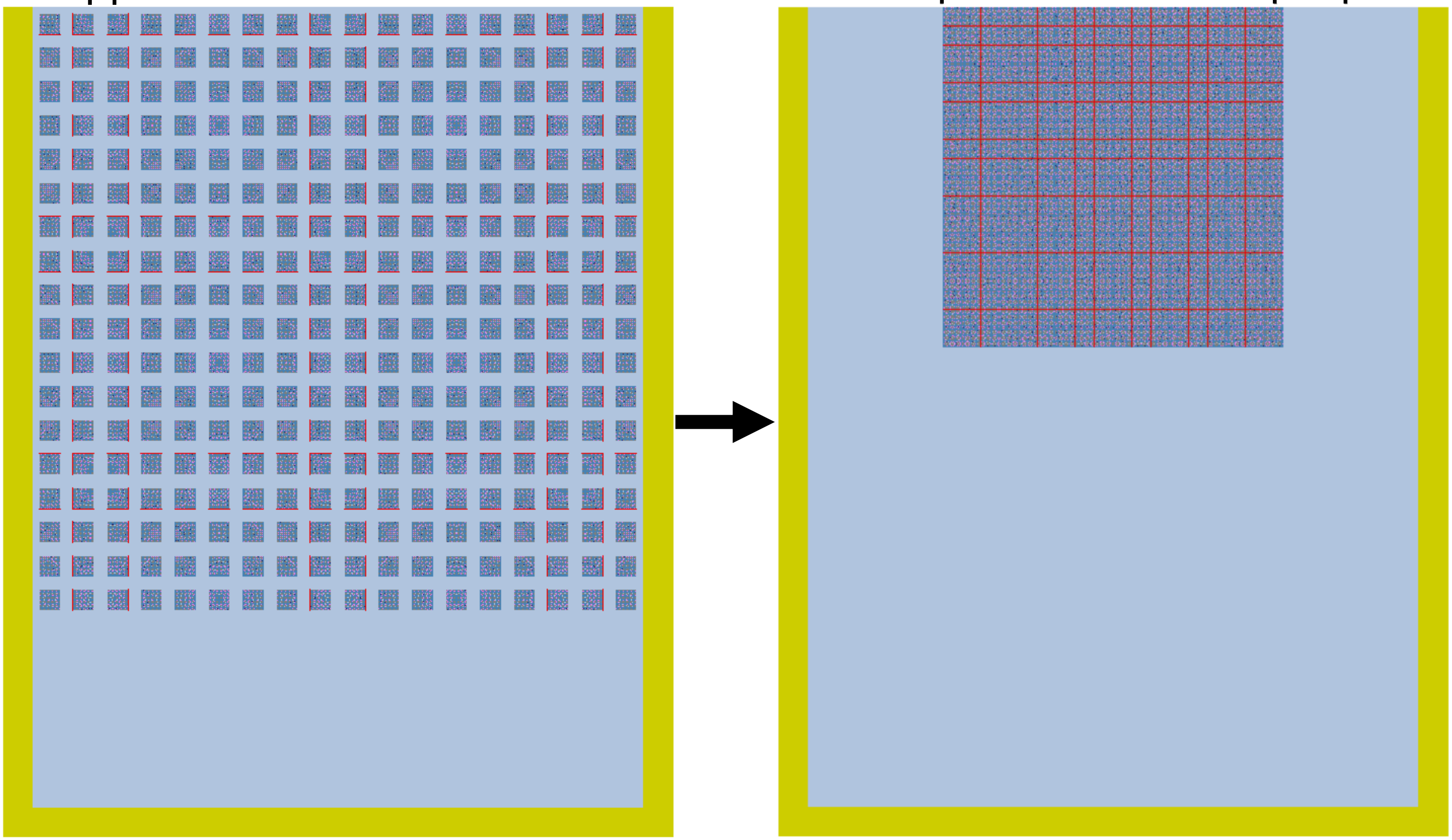
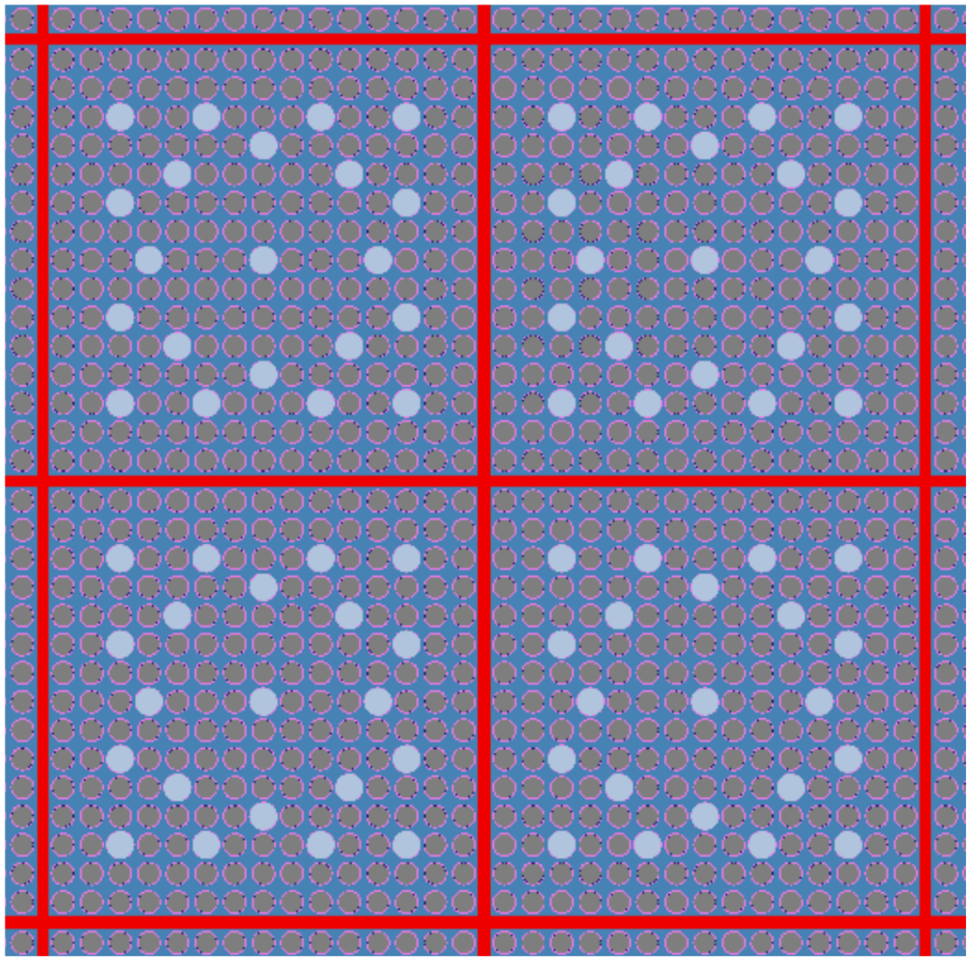
Cask Drop Accident

Dropped cask deforms racks and assemblies to optimum rack and pin pitch



Cask Drop Accident

Dropped cask deforms racks and assemblies to optimum rack and pin pitch



Misload Accidents

- Single and multiple misload accidents are <u>NOT</u> analyzed because they are bounded
  - Region 2 allows storage of fresh assemblies with the maximum allowed enrichment in every cell.
    - There cannot be a Region 2 misload since no credit is taken for burnup, fuel storage geometry, reduced enrichment, etc.
  - A Region 1 misload would be equivalent to Region 2.
    - The only difference between the two regions is that Region 1 (i) is susceptible to the cask drop accident and (ii) credits burnup
    - The cask drop accident and the misload accident are independent events
    - A misload of fresh fuel would be equivalent to Region 2

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Conservatism

- Conservative modeling (e.g. no axial blanket credit, no decay credit)
- NRC administrative margin of 0.01 ΔK reserved to account for minor methodology issues and uncertainties
- Identify Dominion retained margin to allow for future fuel changes and/or methodology issues

Conclusion / Timeline

- Surry SFP and new fuel rack criticality analysis License Amendment Request
  - Increase maximum allowable enrichment
  - Include gadolinium into our Licensing Basis
  - Add soluble boron credit
  - Update methods with RG 1.240
  - Bring computer codes and method in house
  - Increase identified margin

- Major milestones:
  - Submit LAR to NRC Q3 2021
  - Receive SER Q4 2022
  - Implement new TS Q1 2023

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Criticality Analysis Checklist

- See attached completed checklist
- Includes placeholders for analysis Scope, Methods, and Details
- Some items not included or not applicable
  - Justification or explanation provided

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