ENCLOSURE 4

Plant Effluent Calculations for the Westinghouse SMR DCD Submittal, Alternative Approaches to GALE

(Non-Proprietary)

Plant Effluent Calculations for the Westinghouse SMR DCD Submittal

Alternative Approaches to GALE

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Overview

- Introduction
- Planned Methodology for ANS 18.1 Nuclides
- Planned Methodology for Tritium & C-14
- Verification and Validation
- Discussion / Questions

Introduction

- Standard Review Plan Sections 11.2 & 11.3 First Acceptance Criterion:
  - 10 CFR 20.1302 which references
    - 10 CFR 20 Appendix B
- During design certification, compliance is demonstrated by presenting projected liquid and gaseous effluent concentrations
  - Supports DCD Sections 11.2 and 11.3.
  - 11.2 -> liquid waste management system
  - 11.3 -> gaseous waste management system

Introduction

- Regulatory Guide 1.112 further clarifies acceptable practices for demonstrating compliance

- Effluent activity has typically been predicted with the PWR-GALE Code (NUREG-0017)
- However:
  - GALE reflects operating plant data from a few plants during the initial operating period
  - GALE results generally over-estimate plant activity releases
  - GALE (1986) does not represent "best estimate" for a modern PWR

Introduction

- Therefore:
  - Westinghouse has undertaken a re-examination of the effluent activity projections for the SMR DCD submittal
  - Effluent release projections for all isotopes except tritium will be calculated mechanistically by a new code:
    - REAP (Radioactive Effluents for Advanced Plants)
  - Tritium & C-14 effluent release projections will be calculated separately
    - Tritium's chemical properties are different from other isotopes
    - Carbon-14 not included in ANS 18.1
- Important caveats:
  - GALE-calculated results for Westinghouse-SMR expected to be within 10CFR20 Appendix B limits
  - Westinghouse-SMR DCD will include sufficient detail for NRC validation

Planned Methodology for ANS 18.1 Nuclides

- REAP is currently being developed by Westinghouse
  - Completely new codebase, engineered pursuant to modern best-practices of software development
  - Technical report submitted with the DCD submittal

Source Term

- REAP will apply ANSI/ANS-18.1 to determine primary and secondary side source terms during normal operation

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Planned Methodology for ANS 18.1 Nuclides

Source Term

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Nuclear Data

- Half-life and branching fraction data from the latest ORIGEN-S decay data library

Planned Methodology for ANS 18.1 Nuclides

Activity Transport Calculations

- Time-dependent, mechanistic treatment of radioactive liquid and gas flow between tanks and components

- Values that are currently hard-coded in GALE will be treated mechanistically

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Planned Methodology for ANS 18.1 Nuclides

Activity Transport Calculations

- Equations account for:

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Planned Methodology for ANS 18.1 Nuclides

Activity Transport Calculations

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Planned Methodology for ANS 18.1 Nuclides

Unplanned Releases

- GALE includes an arbitrary 0.16 Ci/yr adder that is intended to account for operator error and/or unplanned release of activity

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Output

- Expected annual release for each radionuclide at each identified release point

Planned Methodology for ANS 18.1 Nuclides

- REAP will replicate or improve upon the calculations performed by GALE
  - The source term inputs will be derived from the latest version of ANS 18.1

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  - Calculated effluent values will be “best estimate”, more consistent with relevant measured data

Planned Methodology for "Other" Nuclides

- C-14, Ar-41, and H-3 are traditionally normalized to historical data

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Planned Methodology for Tritium

Overview

- Some background…
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- Development Plan Moving Forward
- Conclusions

Planned Methodology for Tritium

Background

- The available methods to predict tritium discharge are:
  - Mechanistic in nature (TRICAL)
  - Focused on H-3 generation aspects
- Additional analyses have been performed to understand and improve these models by looking at the neutron-nucleus interaction and cross-sections
- A study has indicated that secondary neutron sources have a significant impact on the tritium generation term

Planned Methodology for Tritium

Background

- The current methods lead to overly conservative estimates of tritium activity release (as compared to measured data)

- There is a clear need to improve the comparison with measured plant data to be able to support a licensing strategy for multi-unit sites such as the Small Modular Reactor

Planned Methodology for Tritium

Applicability

- H-3 production pathways in the SMR should be similar to existing PWRs:
  - Neutron capture in soluble boron
  - Production in and release from secondary source rods
  - Lesser contributors (ternary fission, reactions with neutron poison, reactions with soluble lithium, and reactions with deuterium)
- The relative importance of these pathways has not been validated

Planned Methodology for Tritium

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Planned Methodology for Tritium

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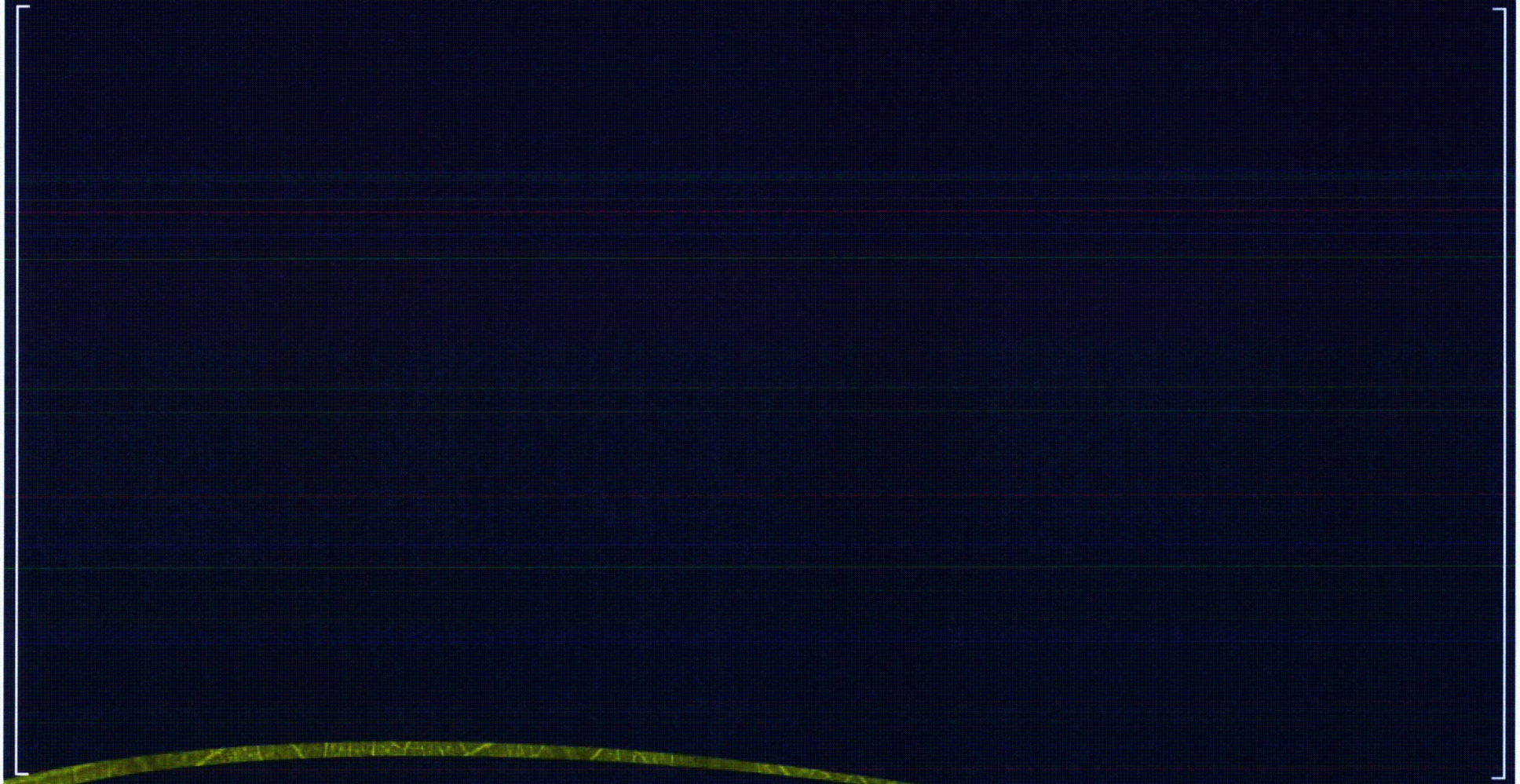

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Overall REAP / ANN Verification and Conclusions

- Use of rigorous software design processes / procedures
- Plan to perform comparisons of results to
  - Operating plant data (where applicable)
  - Data from REIRS database

Discussion / Questions