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Westinghouse Nuclear Safety Culture

Show Respect For Others

Follow The Rules

Stop When Unsure

Promptly Report Problems

My Signature Is My Word

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Cobalt-60 Production in Westinghouse PWRs

NRC-Westinghouse Technical Exchange Meeting

July 15, 2020

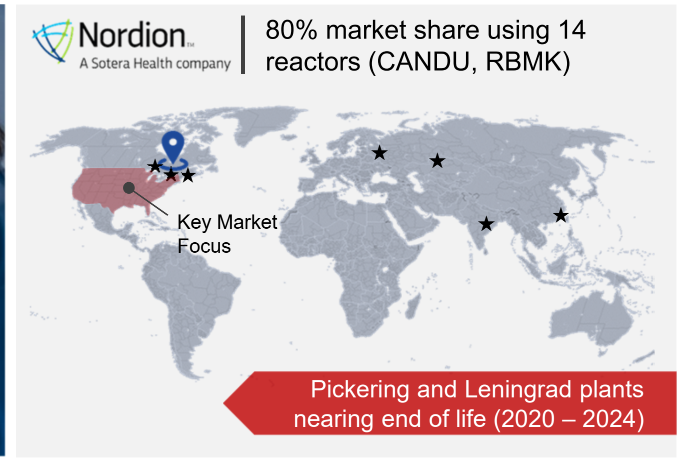
Agenda

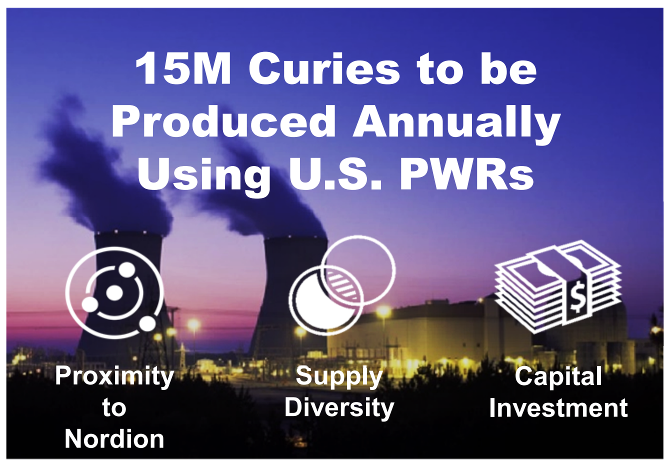
- Background & Objective
- Licensing approach
- Co-60 Production Process
- [ ]a,c
- Safety Analyses, Dose Rates, & SFP Criticality
- Harvesting
- Schedule
- Summary & Closing Statements

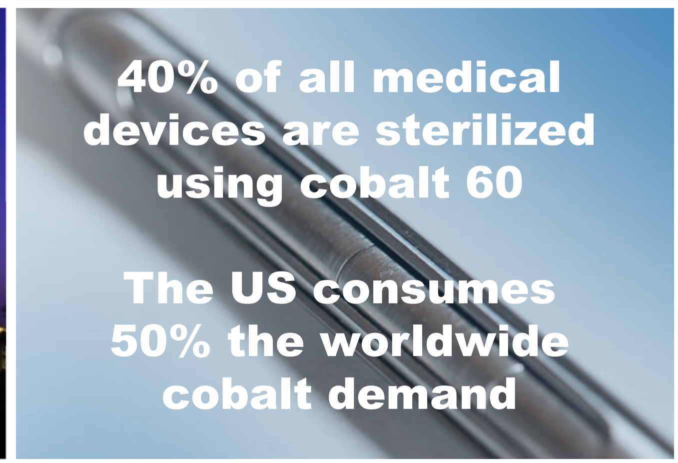
Background: Cobalt-60 Global Production

FEBRUARY 26, 2020

Westinghouse and **Nordion (Canada) Inc.** announce that they have signed a Letter of Intent to develop innovative isotope production technology that will allow Cobalt-60 to be produced in Pressurized Water Reactors (PWRs).







Objective

- Initial dialogue with NRC Staff to provide clarity
  - Licensing approach
  - Production process
  - Component structure & design
  - Applicability of NRC-approved codes and methods
  - Production schedule

Licensing Approach

- Plant-specific Operating License will need to be amended for the inclusion of a 10 CFR Part 30 license, "Rules of General Applicability to Domestic Licensing of Byproduct Material"
- Westinghouse will prepare a technical report to supplement the License Amendment Request (LAR)
- Changes to the Technical Specifications will be made if required
- UFSAR updates will be required

Licensing Approach (contd.)

- Current NRC-approved codes and methods remain applicable for core design and reload safety evaluations

[ ]a,c

[ ]a,c

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Cobalt-60 Production

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[ ]

Key Design Considerations

- Preclude cobalt, reactor coolant interaction
  - [ ][a,c]
- Reducing foreign material in harvesting area as low as reasonably practical
  - Design to allow easier harvesting
- Crediting existing licensed designs
  - Use pre-licensed containers / casks without modifications that would require relicensing

[ ][a,c]

Nuclear Design & Safety Analyses

- Areas of focused analysis
  - Nuclear Design impacts
  - Doses
  - SFP criticality

- Anticipate no impact to the Analysis Of Record
  - Loss of Coolant Accident
  - Fuel Rod Design
  - Thermal-Hydraulic Design
  - Transient Analysis
  - Reload safety analyses

Current NRC-approved codes and methods remain applicable for modeling [ ]a,c

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Modeling of [ ]a,c

- Fairly simple Cobalt depletion chain to model :
  - $^{59}Co + {}^{1}n \rightarrow {}^{60}Co$
    - $^{60}Co \rightarrow {}^{60}Ni + \beta + \gamma$
    - $^{60}Co + {}^{1}n \rightarrow {}^{61}Ni$
- Depletion chain added to existing NEXUS / PARAGON / ANC code system
  - No changes to basic neutronic solution methods already reviewed / approved by U.S. NRC

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Expect accurate prediction of Co depletion with current code system

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Modeling of [ ]a,c (contd.)

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Modeling of [ ]a,c (contd.)

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Typical 18-Month Loading Patterns No [ ][a,c]

[a,c]

Example 18-Month Loading Patterns With [ ]a,c

[ ]a,c

[ ]a,c Impacts on Core Design

a,c

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[ ]a,c Impacts on Safety Analyses

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Spent Fuel Pool Building Dose Rate

- Typical NPP Fuel Building Radiation Zoning above spent fuel pool (SFP) < 2.5 mRem/hr (i.e., Zone III)

- Dose Rate Contributed from
  - SFP Water Source Terms
  - Elevated Irradiated Fuel Assembly in Movement (at least 10 feet underneath the SFP water surface)

- Co-60 is a major gamma source (5.271 years half-life)
  - Emits 1.173 MeV and 1.332 MeV gamma rays
  - Cascade decay with almost 100% branching ratio
  - About [ ]a,c Co-60 produced each unit per campaign

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Spent Fuel Pool Building Dose Rate (contd.)

- SFP Water Source Terms (Typical)

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Spent Fuel Pool Building Dose Rate (contd.)

- Elevated Irradiated Fuel Assembly in Movement (10 feet underneath the SFP water surface)

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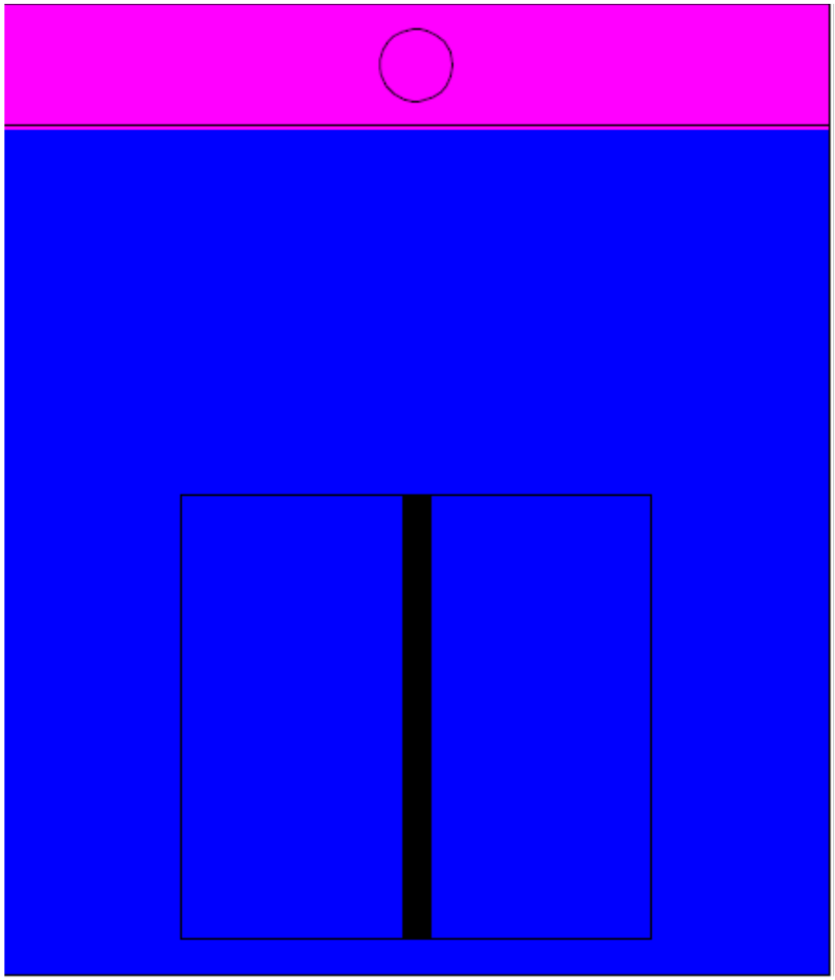

Spent Fuel Pool Building Dose Rate (contd.)

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Spent Fuel Pool Dose Rate Summary

- Co-60 bearing assemblies are expected to yield higher dose rates than a standard assembly during movement

- Westinghouse will be performing detailed evaluations to assess dose rate above the water surface while moving irradiated [

  ]^{a,c}

- Site-specific radiation zone mapping will be updated if necessary

Spent Fuel Pool Criticality

- SFP criticality will be performed on a plant specific basis.

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Harvesting

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Harvesting (contd.)

a,c

Harvesting (contd.)

a,c

Harvesting (contd.)

a,c

Harvesting (contd.)

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Co-60 Activity Measurements

- Platinum Self Powered Detector (SPD) has established Co-60 gamma sensitivity[1]
  - Generates current from both Compton and photoelectric effects

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(1) International Electrotechnical Commission (IEC) 61468 standard: Nuclear Power Plants – Instrumentation Systems Important to Safety – In-Core Instrumentation: Characteristics and Test Methods of Self-Powered Neutron Detectors

Transportation of Co-60 [ ]a,c

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Transportation of Co-60 [ ]a,c (contd.)

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Schedule

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Summary

- Changes anticipated to the operating license, but not to the Technical Specifications
- Previously licensed process in the U.S. (Hope Creek, Clinton)
- Leveraging the existing processes/procedures for Westinghouse PWRs that can be extended to Co-60 production

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Utility Interest

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