



U.S. DEPARTMENT OF  
**ENERGY**



**SRNL**  
SAVANNAH RIVER NATIONAL LABORATORY  
Operated by Savannah River Nuclear Solutions, LLC

# Experience with In-Situ Decommissioning as a Remediation End Point

**Helen Belencan**

Senior Advisor  
United States Department of Energy  
Savannah River Site



***International Atomic Energy Agency  
International Experts' Meeting on Decommissioning and Remediation  
After a Nuclear Accident  
28 January – 1 February, Vienna, Austria***

# INTRODUCTION

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- ❑ In 2011, the United States Department of Energy (USDOE) successfully decommissioned two former nuclear materials production reactors
- ❑ A remediation approach, according to United States Environmental Protection Agency (USEPA) regulations, was followed
- ❑ Both reactors were entombed, or in-situ decommissioned



Before decommissioning



After decommissioning



## KEYS to SUCCESS

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- An established regulatory structure within which to work
- Robust and meaningful regulator and stakeholder involvement efforts
- Technically viable, environmentally protective, and defensible end state plan



# AN ENVIRONMENTAL REMEDIATION FRAMEWORK PROVIDED STRUCTURE

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**A joint 1995 policy between the USEPA and the USDOE established the use of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as the framework for decommissioning USDOE defense nuclear facilities**

- This framework establishes a risk-based end state in consideration of potential future use of the area, such as
  - Residential
  - Industrial
  - Recreational
- Ensures protection of worker and public health and the environment
- Provides for stakeholder involvement
- Achieves risk reduction without unnecessary delay
- Seeks a permanent, final solution



# END STATE SELECTION INCLUDES ANALYSIS AGAINST NINE CRITERIA

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**Alternatives are analyzed individually against each criterion and then compared against one another to determine respective strengths and weaknesses and to identify key trade-offs that must be balanced**

- Threshold Criteria
  - Overall protection of human health and the environment
  - Compliance with other state and federal regulations
- Primary balancing Criteria
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility, or volume
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying Criteria
  - Regulatory acceptance (State government and/or USEPA)
  - Community acceptance





### 3 ALTERNATIVES WERE EVALUATED

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- No action, facility would remain in its current condition indefinitely
- In-situ decommissioning with land use controls
  - Stabilize/isolate contamination remaining within facility
  - Limit contamination migration of radioactive or hazardous contaminants to groundwater to prevent radioactive or hazardous contaminant exposure to industrial worker or animal intruder
- Complete removal, which would return reactor footprint to green-field condition



# Comparison of Alternatives Against CERCLA Threshold and Primary Balancing Criteria

Criteria \ Alternative	No Action	In-Situ Decommissioning	Complete Removal
Overall Protectiveness of Human Health and Environment	No	Yes	Yes
Compliance with Other State and Federal Regulations	No	Yes	Yes
Reduction of Toxicity, Mobility, or Volume	Poor	Good	Good
Long-Term Effectiveness	Poor	Medium	High
Short-Term Effectiveness	None	High	Low
Implementability	Not Applicable	Easy	Difficult
Cost	\$0	\$52 to \$236M	\$366M



# INPUT FROM STAKEHOLDERS

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- Savannah River Citizen Advisory Board (CAB)
  - 25 member board provides advice, information, and recommendations on issues:
    - Clean up standards and environmental restoration
    - Waste management and disposition
    - Stabilization and disposition of non-stockpile nuclear materials
    - Excess facilities
    - Future land use and long-term stewardship
    - Risk assessment and management
    - Clean-up science and technology activities
- Workshops conducted throughout area allow interested stakeholders an opportunity to discuss various elements of the plans for reactors





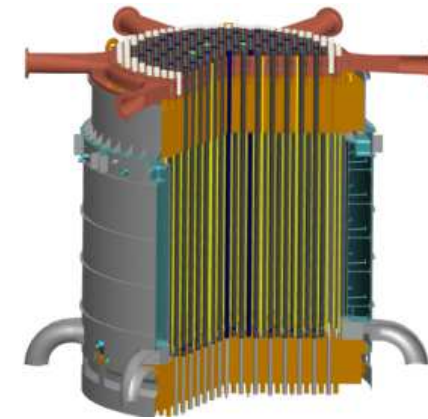
# CONSTRUCTION OF A REACTOR MODEL

- ❑ Physical model and a virtual 3D model of reactor was used as important tool for communication and work planning:
  - ❑ Provides means to learn about reactor and appreciate it's scale and complexity
  - ❑ Used to develop grouting strategy, determine grout quantities, and direct work planning



# CEMENTITIOUS MATERIALS DESIGNED, TESTED, AND PLACED

- ❑ Majority of below grade areas – portland cement based fill
- ❑ Special below grade areas – portland cement cellular lightweight flowable fill
- ❑ Reactor vessel – low pH fill specialty cements designed to avoid reaction with aluminum and generation of hydrogen
  - ❑ Calcium sulfoaluminate fill
  - ❑ Magnesium sulfoaluminate fill
- ❑ Caps – portland cement shrinkage compensating concrete



Reactor Vessel Diagram



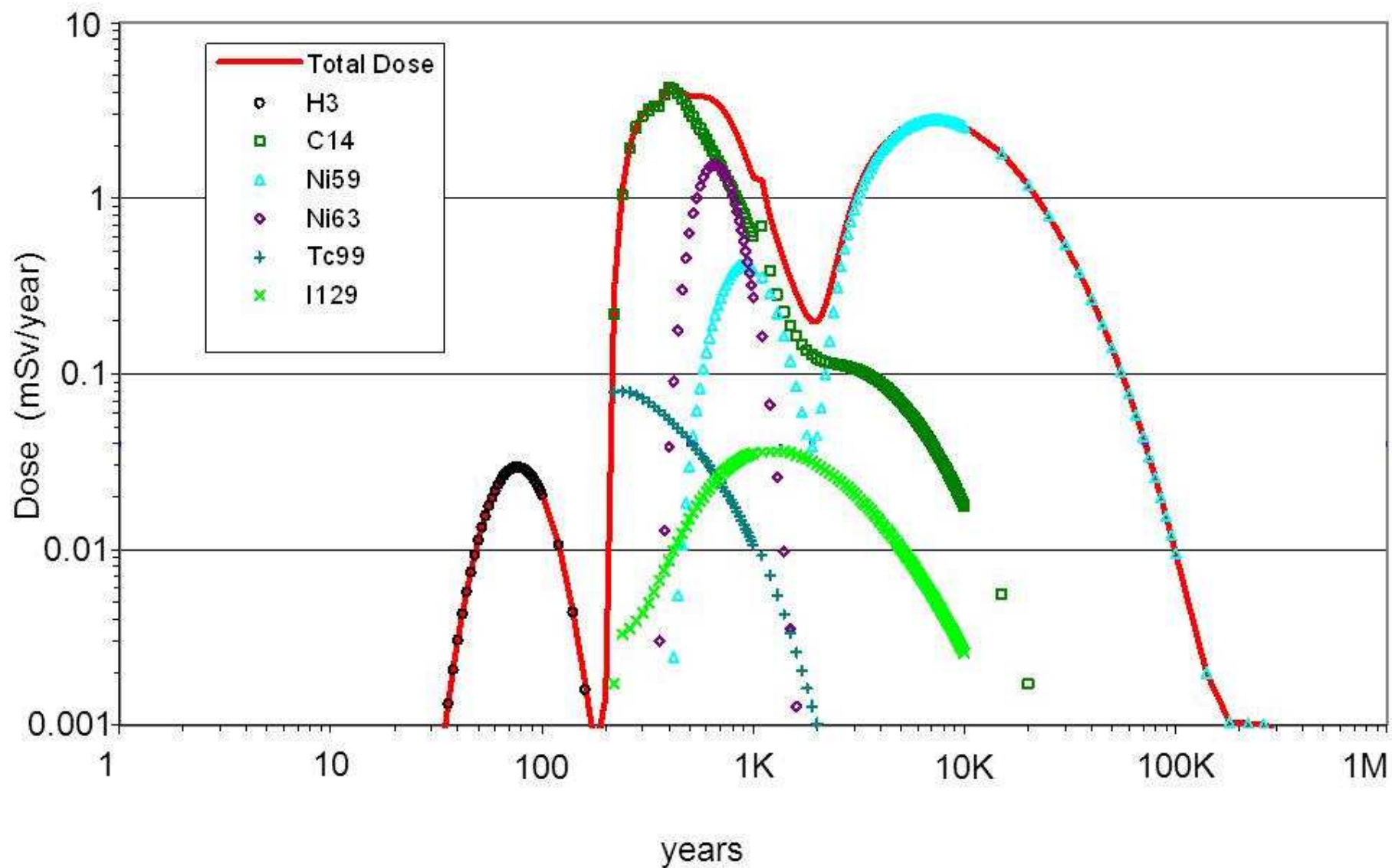
# ACCEPTABILITY OF IN-SITU FROM ENGINEERING AND SCIENTIFIC BASIS

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- Environmental contaminant modeling was conducted to assess:
  - Effectiveness of the end state
  - Provide a transparent technical basis
  - Assure regulators and public of long-term stability and environmental protectiveness of in-situ decommissioned facilities
- Models of structural stability of reactors
  - Projected stability of major facility elements for greater than 1000 years
    - Structural elements not capable of 1000 year survival were demolished



# CONTAMINANT MIGRATION - P REACTOR IF NO ACTION



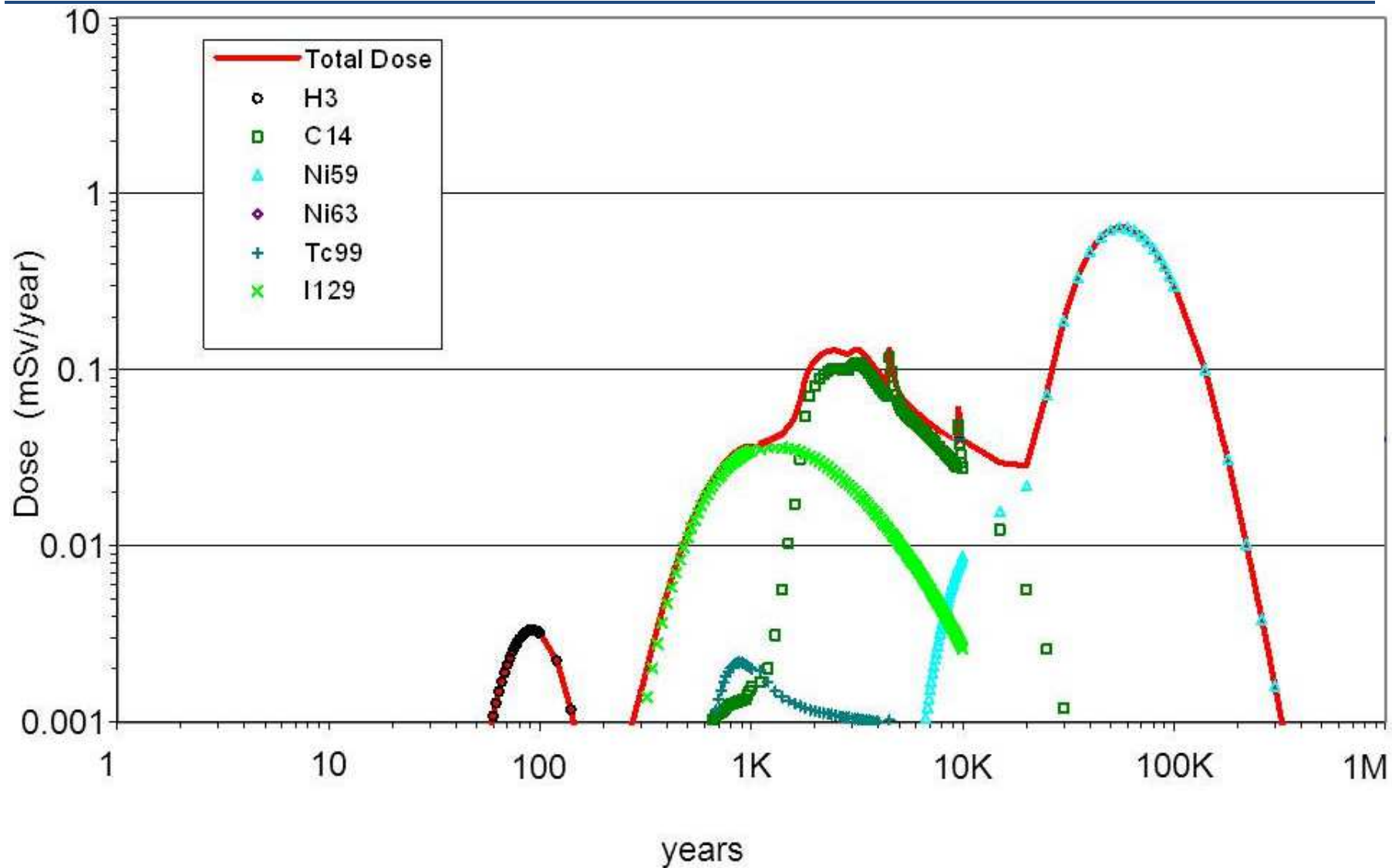
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# CONTAMINANT MIGRATION - P REACTOR AFTER DECOMMISSIONING



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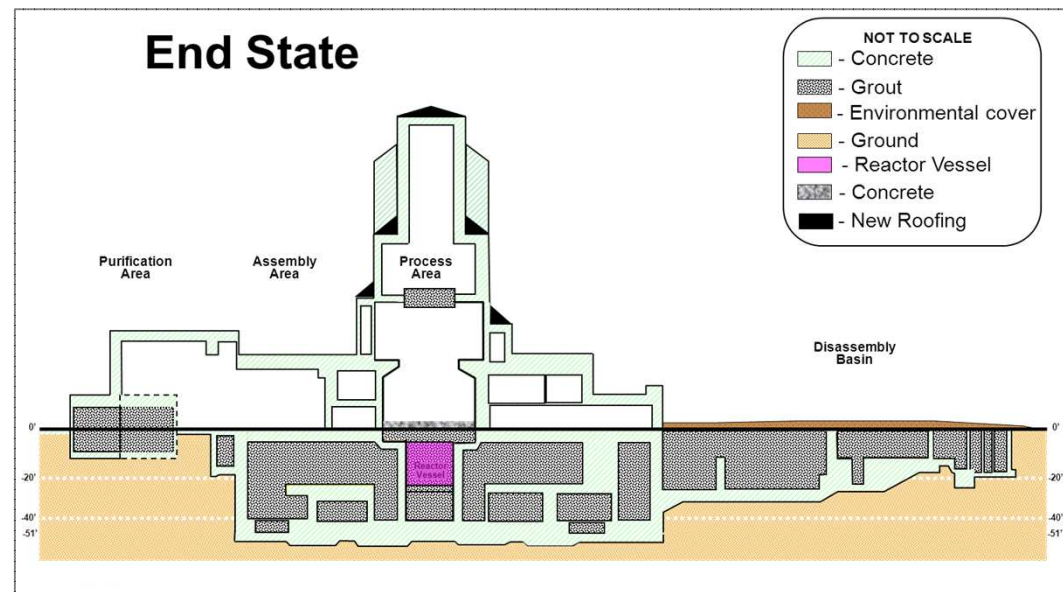
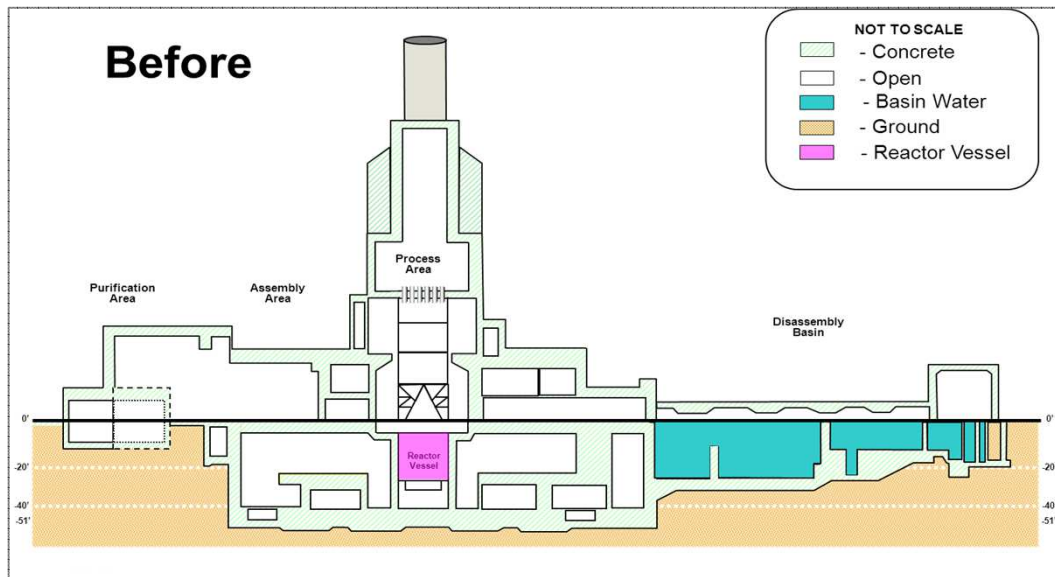


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# BEFORE AND AFTER PICTURES OF IN-SITU DECOMMISSIONING





## SUMMARY

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- ❑ Two Nuclear Reactors at Savannah River Site were successfully decommissioned in 2011
- ❑ In-situ decommissioning was demonstrated as viable alternative to standard demolition and disposal practice
- ❑ Actual cost of \$70 Million for one reactor compared favorably to a cost estimated greater than \$250 Million for demolition of one reactor and transportation of debris to a disposal facility (excluding burial costs)
- ❑ In-situ decommissioning provided a permanent solution that is protective of the environment, the worker, and the general population



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## Contact Information

Helen Belencan  
Senior Advisor, US Department of Energy  
Savannah River Site  
[Helen.Belencan@srs.gov](mailto:Helen.Belencan@srs.gov)



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