State-of-the-Art Reactor Consequence Analyses (SOARCA)

Public Meeting
Soddy-Daisy, TN
April 20, 2016



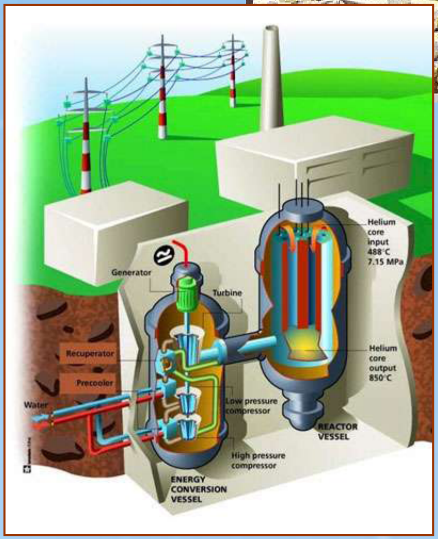
NRC's Office of Nuclear Regulatory Research (RES)

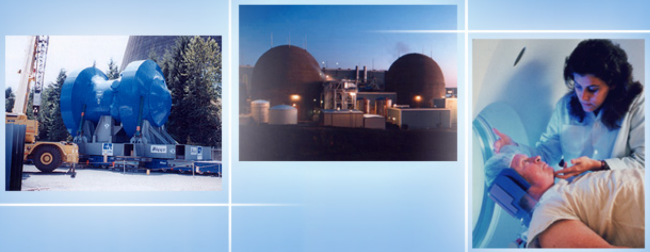
Who We Are:

- Major NRC program office
- Mandated by Congress
- Engineers, scientists, analysts
- Located in Rockville, MD

RES: What We Do

- Develop technical bases to support regulatory decisions
- Provide in-house technical expertise to licensing offices and the Regions
- Manage projects with National Labs and independent contractors
- Anticipate NRC's future needs
  - Develop technical infrastructure for advanced reactor licensing reviews
  - Support new reactor licensing
  - Develop Long-Term Research Plan





What Is SOARCA?

- SOARCA was initiated to develop a body of knowledge on the realistic outcomes of potential severe reactor accidents
- Pilot plants examined in study: Peach Bottom, Surry, and Sequoyah

Peach Bottom

Surry

Sequoyah



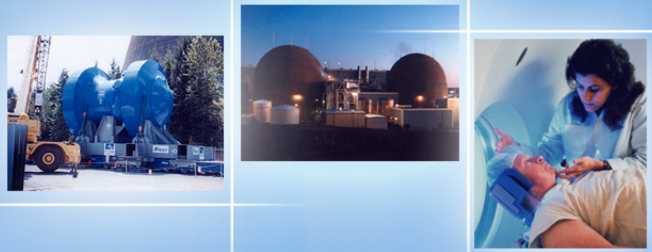
Why Did We Do SOARCA?

- Update the quantification of potential offsite consequences
- For Surry and Peach Bottom we incorporated plant changes not reflected in earlier assessments
- For Sequoyah we evaluated the benefit of igniters
- Incorporate state-of-the-art modeling (MELCOR/MACCS)
- Enable the NRC to communicate severe accident aspects of nuclear safety

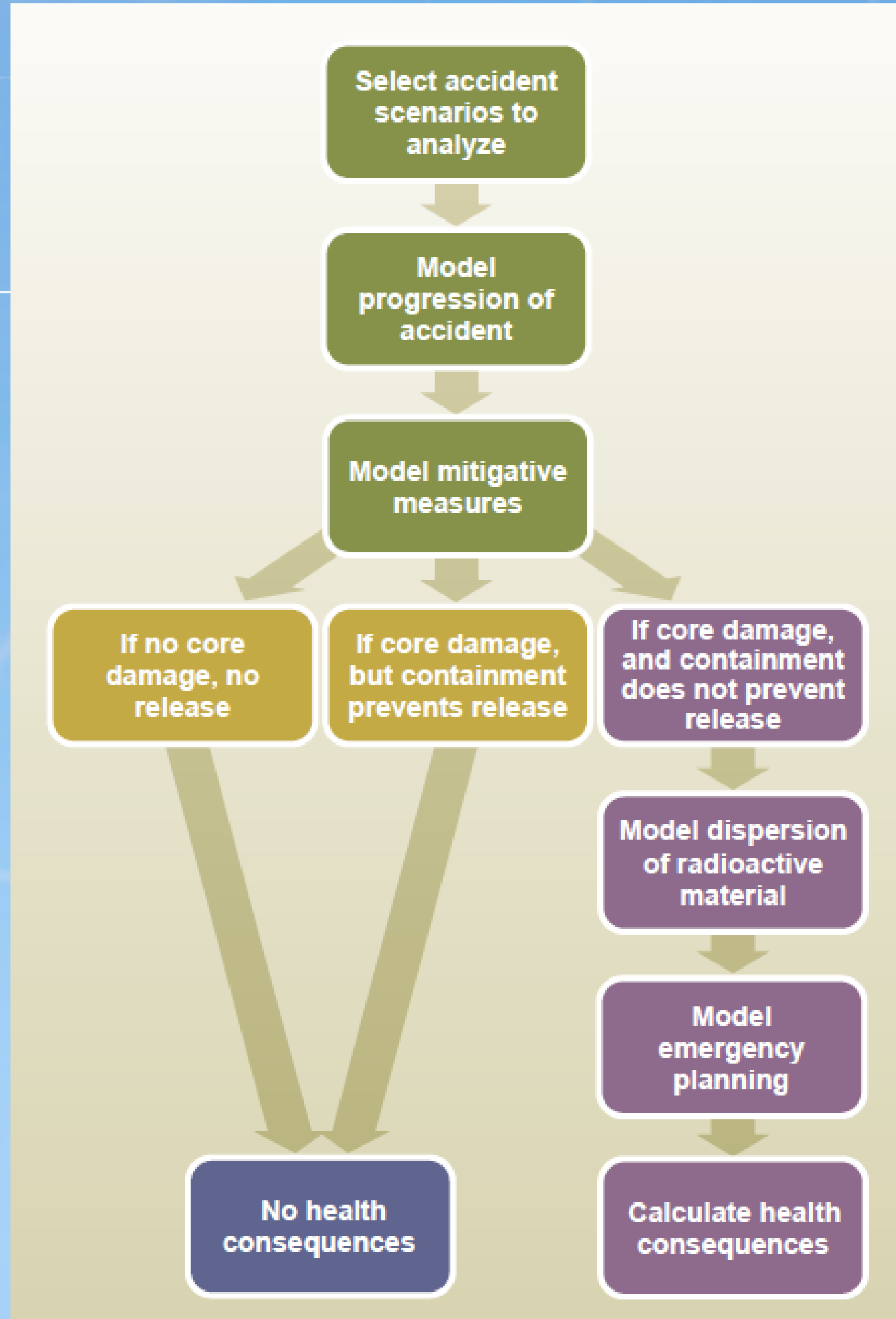


How Is SOARCA Different?

- Focus on important potential severe accident scenarios
- Realistic assessments and detailed analyses
- Integrated analyses
- Incorporated recent physical experiments
- Treatment of seismic impacts on evacuation
- Range of health effects modeling



How Did We Do SOARCA?

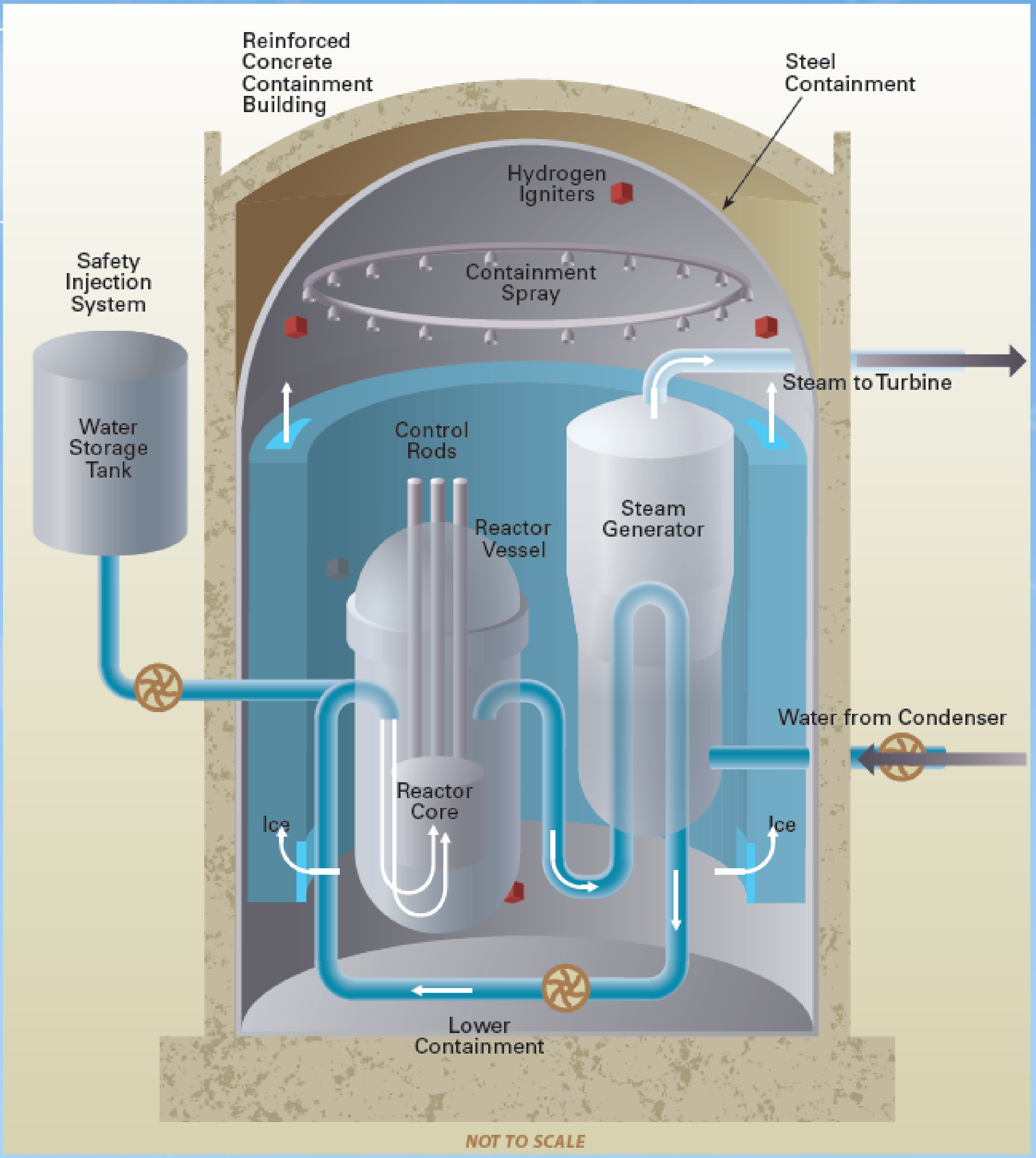




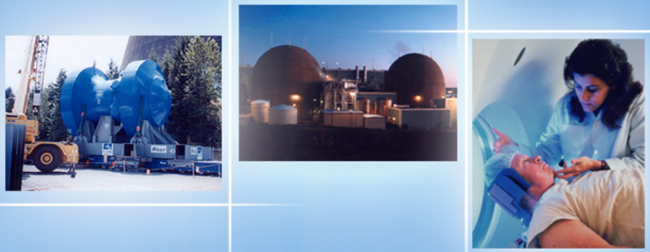
What Scenarios Were Analyzed?

Reactor Site	Accident Scenario	Description
Peach Bottom, Surry, and Sequoyah	Long-Term Station Blackout	Seismic event; loss of AC power; batteries available initially
Peach Bottom, Surry, and Sequoyah	Short-Term Station Blackout	Seismic event; loss of AC power; batteries unavailable
Surry	Short-Term Station Blackout with Steam Generator Tube Rupture	Variation of STSBO. A steam generator tube ruptures resulting in a pathway for radioactive material to potentially escape
Surry	Interfacing Systems Loss-of-Coolant Accident	A random failure of valves ruptures low-pressure system piping outside containment

Ice Condenser Containment



U.S. Nuclear Regulatory Commission



How Were The Accidents Modeled?

- MELCOR's detailed, integrated computer model includes the reactor, plant systems, plant buildings
- MELCOR calculates accident scenario progression and release of radioactive material
  - Physics and chemistry models: water boil-off in the reactor, core overheating and melting, reactor and containment failure, release of radioactive material
- MACCS calculates site-specific atmospheric transport and deposition, protective actions, exposure pathways, and health effects



What Is Mitigation?

- Examples
  - Use of backup power systems to operate hydrogen igniters
  - Procedures to manually (without electricity) operate steam-driven pumps
  - Portable diesel-driven pumps
  - Portable generators to power critical instrumentation and operate valves
  - Portable air bottles to operate valves

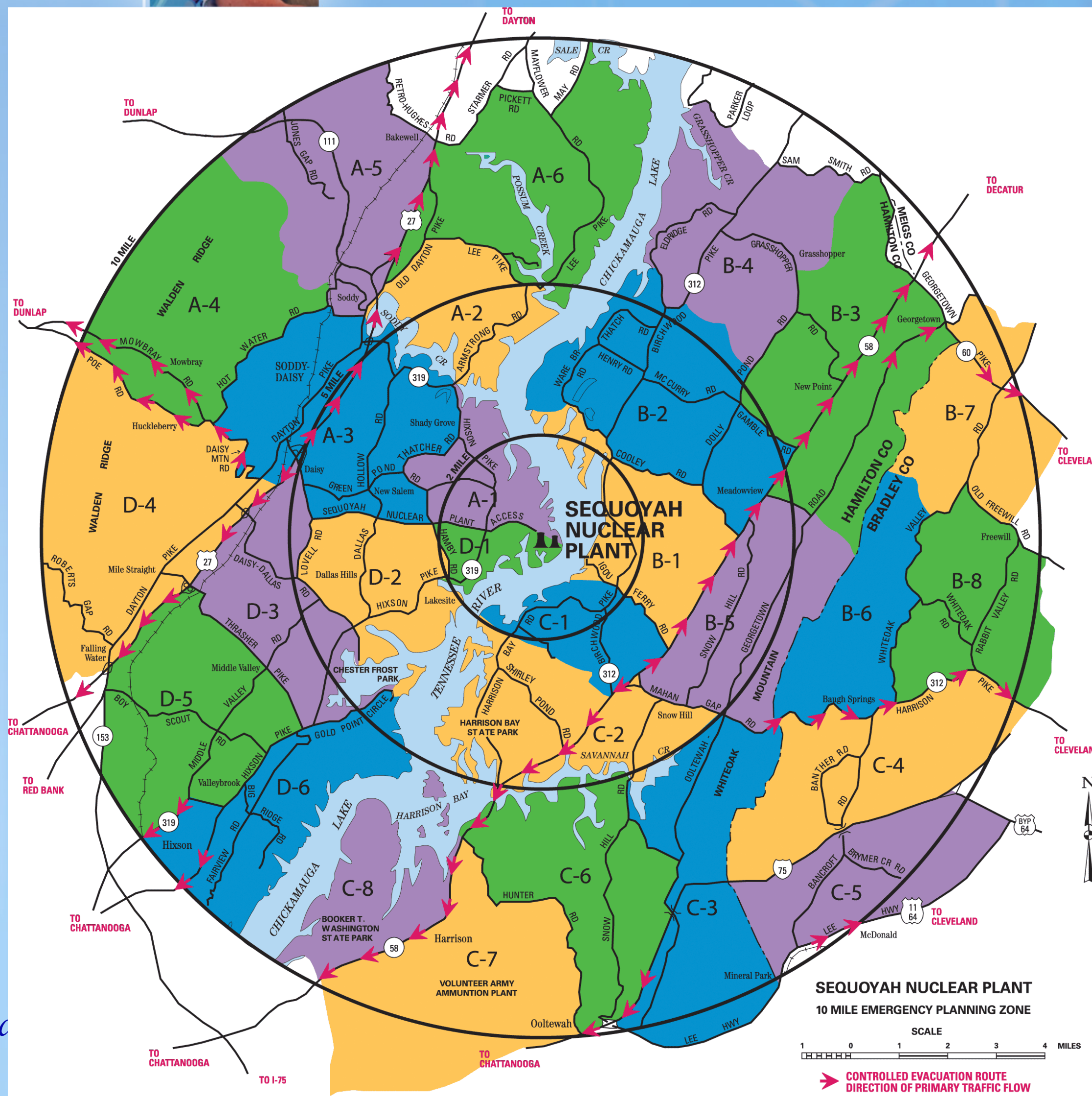


How Did We Model Emergency Response?

- Realistic modeling for emergency response (MACCS)
  - Site, State, and local emergency plans
  - Site's timeline for declaring an emergency
  - State/local protective action procedures
    - Precautionary protective actions modeled
  - Used site Evacuation Time Estimate (ETE) data
  - Real-world examples help show:
    - The public will largely follow direction from officials
    - Emergency workers will implement plans



Sequoyah Emergency Planning Zone





How Are Health Consequences Reported In SOARCA?

- **Early Fatality Risk**—Individual risk of death shortly (usually within a few weeks or months) after exposure to large doses of radiation

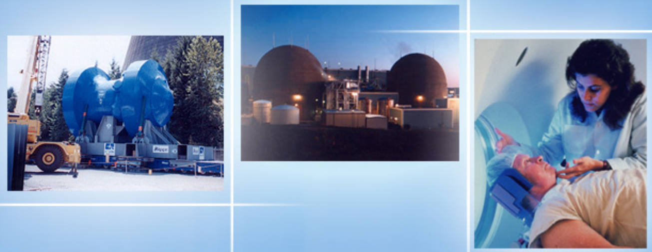
- **Long-Term Cancer Fatality Risk**—Individual risk of cancer fatality years after exposure to radiation



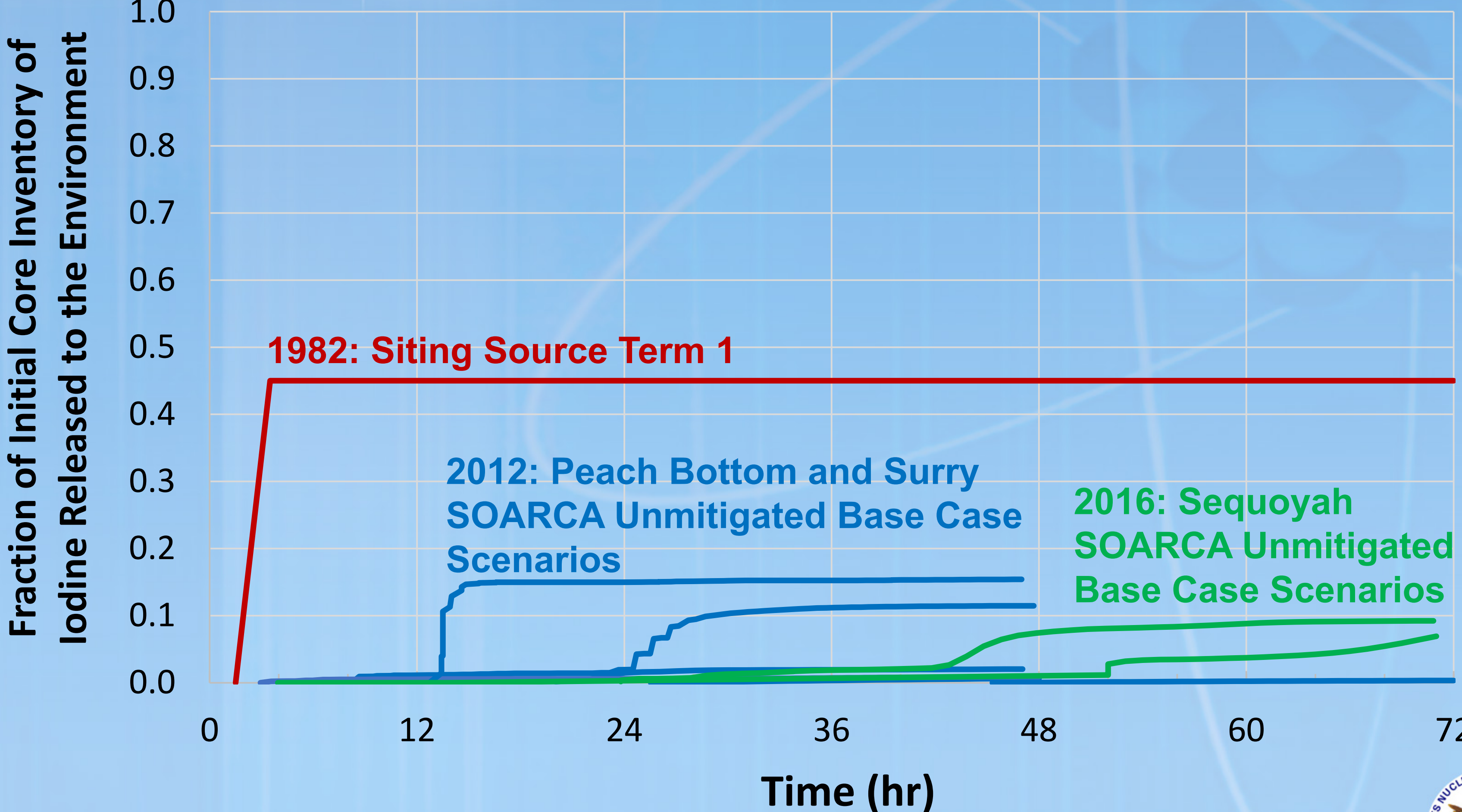
SOARCA Results

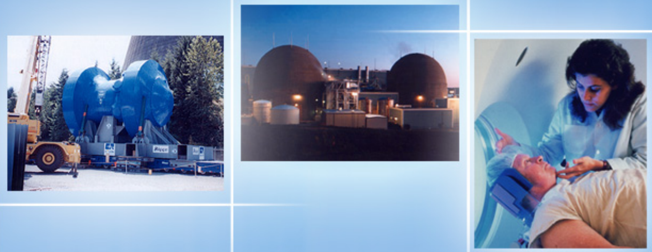
- When operators are successful, for scenarios modeled, they can prevent the reactor core from melting, or delay or reduce releases of radioactive material

- Modeled accident scenarios progress more slowly and release smaller amounts of radioactive material than calculated in earlier studies.



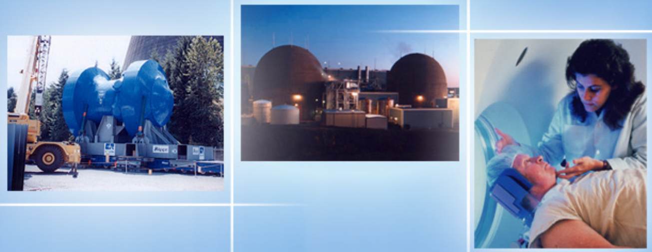
SOARCA Results: Iodine Release To The Environment For Unmitigated Scenarios





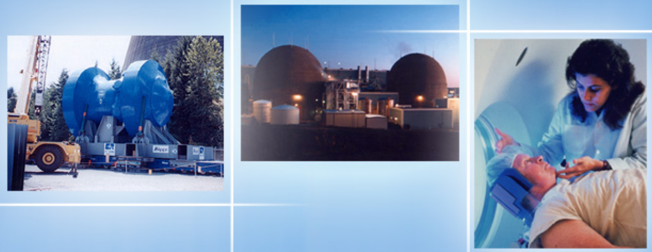
SOARCA Results

- Public health consequences from potential severe nuclear accident scenarios are smaller than previously calculated
- Modeled potential severe accident scenarios in SOARCA cause essentially no early fatality risk
- For Sequoyah, successful use of igniters averts potential early containment failure
- Emergency response actions such as evacuating or sheltering reduce risks to the public



SOARCA Results

- Calculated individual long-term cancer fatality risks for the potential accident scenarios analyzed are millions of times lower than the general U.S. cancer fatality risk



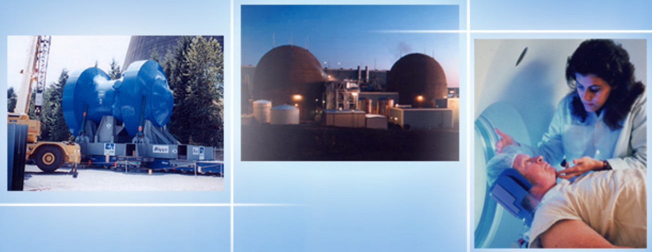
Assessing Uncertainty in Our Results

- Analyzed uncertainty in more detail for a potential accident scenario at each of the three plants
- Varied important parameters and studied the effect on MELCOR and MACCS results
- Even under more challenging conditions considered, accidents progress more slowly and public health consequences are smaller than previously calculated



Next Steps

- Submitted comments will be considered
- NRC staff will provide information to the Commission
  - NUREG technical report
  - Public Comment Summary



Formal Comments On SOARCA

Electronically:

www.regulations.gov

Docket ID: NRC-2016-0074

By Mail:

Cindy Bladey

Office of Administration, Mail Stop: OWFN-12-H08

U.S. Nuclear Regulatory Commission

Washington DC 20555-0001