U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

RIC 2012

DEVELOPMENT AND APPLICATIONS OF MELCOR

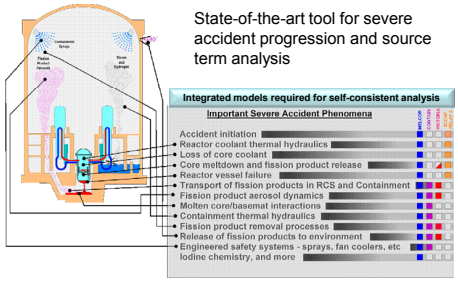
Hossein Esmaili
U.S. NRC/RES
March 15, 2012

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

What is MELCOR?

MELCOR is an integrated system level computer code developed at Sandia National Laboratories for the U.S. Nuclear Regulatory Commission

State-of-the-art tool for severe accident progression and source term analysis

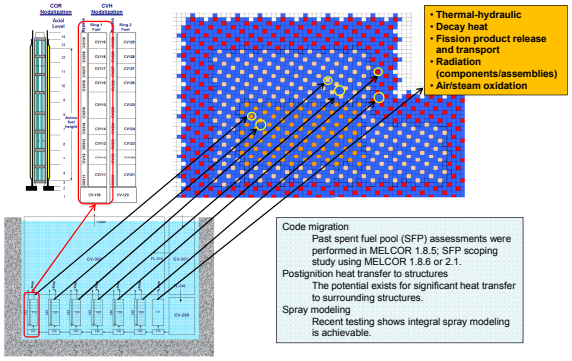


U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Regulatory Applications

- State-of-the-Art Reactor Consequence Analysis (SOARCA)
- Spent Fuel Pool Scoping Study
- DOE/NRC Fukushima Forensic Study
- MOX/HBU Source Term (revised NUREG-1465)
- Design Certification for New and Advanced Reactor Designs
- BWR MSIV Leakage Analysis (RG 1.183)
- Risk-Informed Regulation (e.g., combustible gas control rulemaking)
- Probabilistic Risk Assessment (e.g., standardized plant analysis risk (SPAR) models)

High-Density Postoutage Spent Fuel Pool MELCOR Model



- Thermal-hydraulic
- Decay heat
- Fission product release and transport
- Radiation (components/assemblies)
- Air/steam oxidation

Code migration
Past spent fuel pool (SFP) assessments were performed in MELCOR 1.8.5; SFP scoping study using MELCOR 1.8.6 or 2.1.

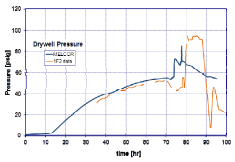
Postignition heat transfer to structures
The potential exists for significant heat transfer to surrounding structures.

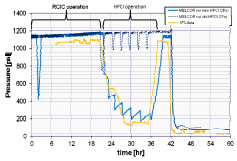
Spray modeling
Recent testing shows integral spray modeling is achievable.

4

Fukushima Accident Analysis

- Severe accident codes such as MELCOR are capable of predicting complex plant response, including operator intervention (EOP) and mitigation (SAMG).
- Forensic analyses are ongoing.



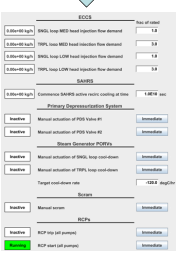


5

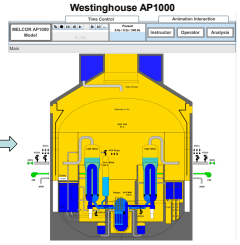
MELCOR/SNAP Accident Simulation

Symbolic Nuclear Analysis Package (SNAP) provides a standard graphical user interface for NRC codes. MELCOR/SNAP coupling in the safety system logic to initiate, fail, or adjust system functionality.

SNAP animation package reads the plot data and performs the display function. The system uses simple and complex elements to display pertinent information from the MELCOR run. It communicates interactive commands from the display page to MELCOR.

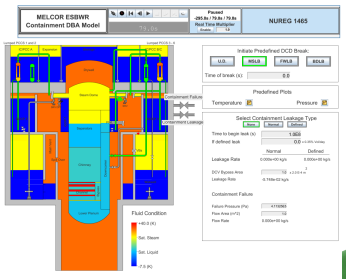


Westinghouse AP1000

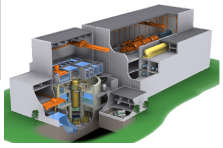


6

MELCOR/SNAP Design-Basis Analysis

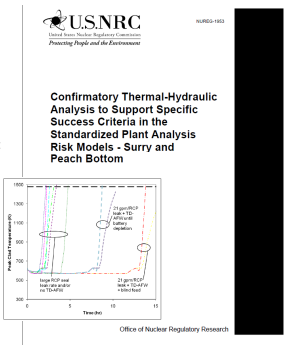


Containment design-basis accident (DBA) analysis models allow for predictions of containment peak pressure and source term. User can select predefined breaks and mass and energy sources or directly input for sensitivity calculations.



PRA Application

- The technical basis for Standardized Plant Analysis Risk (SPAR) models for selected probabilistic risk assessment (PRA) sequences of interest is being improved and the consistency increased.
- Results for Surry and Peach Bottom were published as NUREG-1953.
- Analysis is currently focused on Byron:
  - MELCOR input model developed
  - Ongoing calculations for selected accident sequences
- MELCOR SNAP models are being developed for Peach Bottom and Byron.



Summary

- Code applications and analysis for emerging issues (e.g., Fukushima accident, SFP)
- MELCOR ongoing code development and enhancement in response to regulatory needs
- MELCOR/SNAP integration for an easy-to-use graphical user interface for accident simulation and visualization

Acronyms

- BWR Boiling water reactor
- DBA Design-basis accident
- DOE Department of Energy
- ECCS Emergency core cooling system
- EOP Emergency operating procedures
- HBU High burnup
- LOCA Loss of coolant accident
- MOX Mixed oxide
- MSIV Main steam isolation valve
- NRC Nuclear Regulatory Commission
- PRA Probabilistic risk assessment
- SAMG Severe accident management guidelines
- SFP Spent fuel pool
- SNAP Symbolic nuclear analyzer package
- SOARCA State-of-the-art reactor consequence analysis
- SPAR Standardized plant analysis risk

10