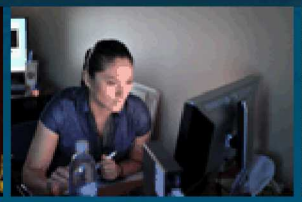
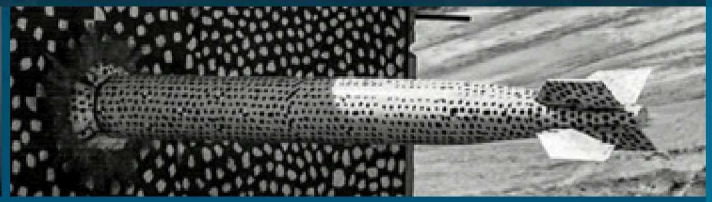
SAND2020-10940PE

Risk-Informed Systems Analysis (RISA) Research Pathway Stakeholder Engagement Meeting





PRESENTED BY

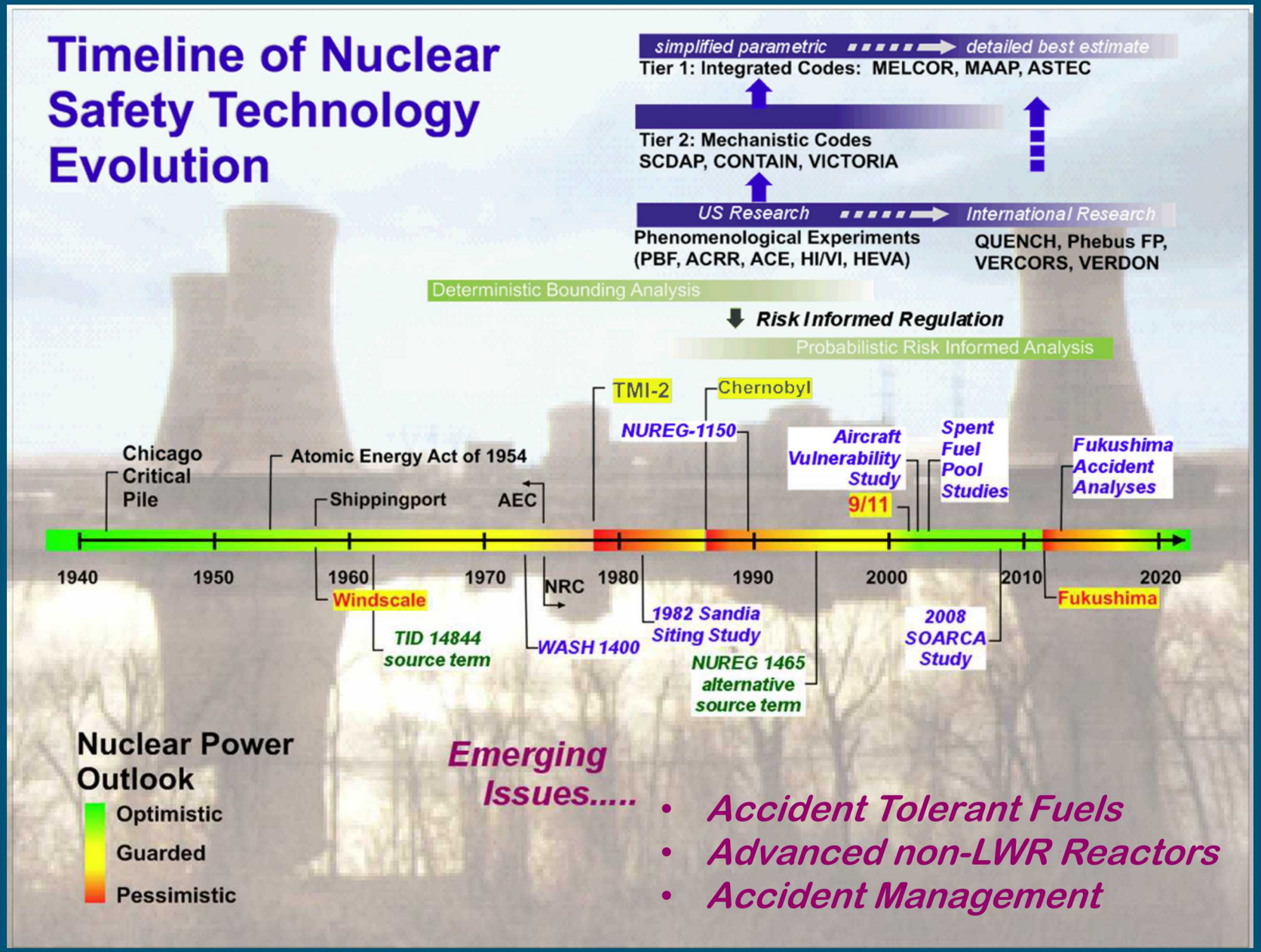
Brad Beeny, Severe Accident Modeling/Analysis (SNL-08852)

SNL MELCOR Modeling/Simulation Efforts Pursuant to TTEXOB Milestone 7

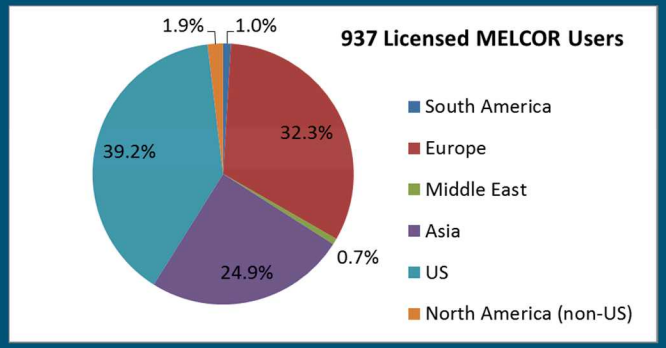
B. Beeny, L. Gilkey, M. Solom (SNL)

C. Faucett (SNL/Texas A&M University)

MELCOR History and Introduction



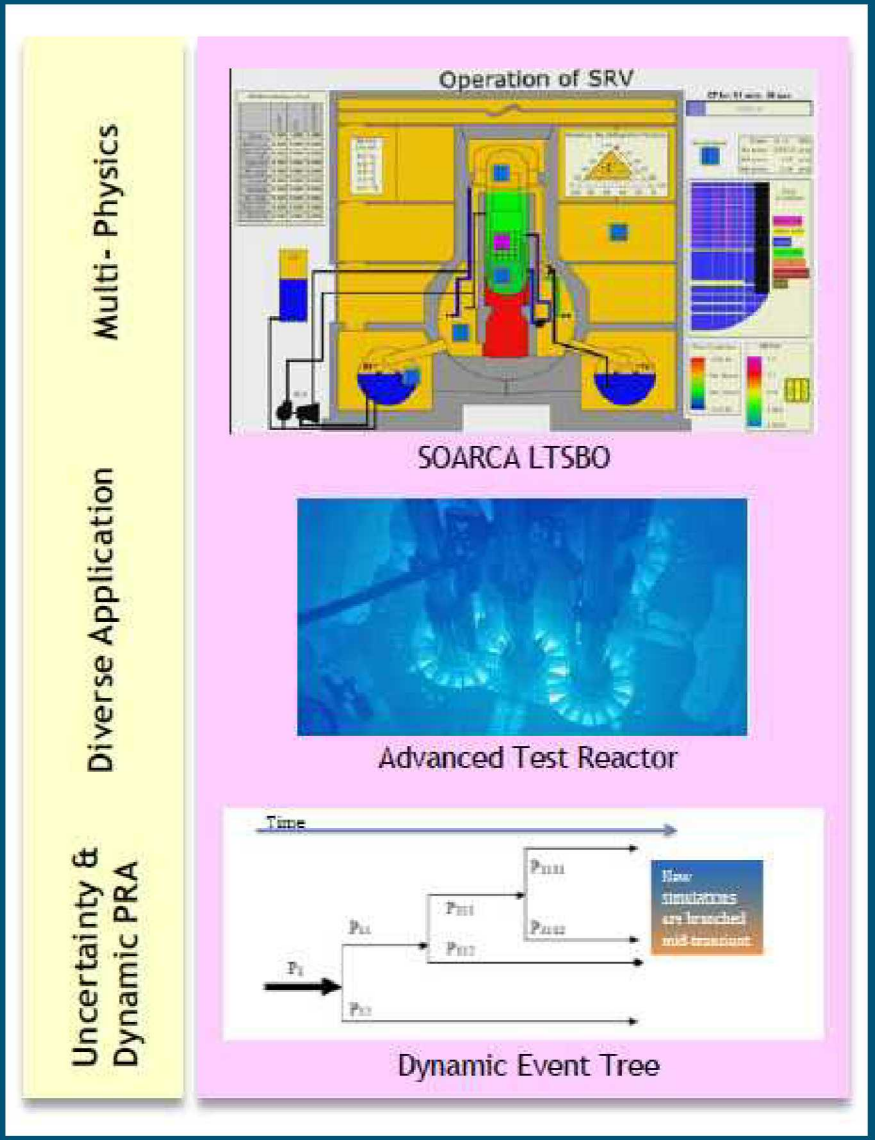
- Began in 1982 shortly after TMI-2
- Replaced Source Term Code Package
- Systems-level approach to modeling
- Emphasis on "best-estimate"
- Repository of knowledge
- Global standard (used by 31+ nations)
  - Users' groups (AMUG & EMUG)
  - Annual CSARP/MCAP meetings



- Used by USNRC, USDOE & US industry
- Used for naval reactors (US/UK)
- Evolves to meet regulatory needs

MELCOR History and Introduction

- Fully integrated, multi-physics engineering-level code
  - Thermal-hydraulic response in the reactor coolant system, reactor cavity, containment, and confinement buildings
  - Core heat-up, degradation, and relocation
  - Core-concrete attack
  - Hydrogen production, transport, and combustion
  - Fission product release and transport behavior
- Diverse application
  - Multiple core designs
  - Models built from basic code constructs
  - Adaptability to new or non-traditional reactor designs (ATR, Naval, VVER)
- Validated physics models (ISP's, benchmarks, experiments, accidents)
- Uncertainty analysis & dynamic PRA (fast-running, reliable, access to parameters)
- User convenience
  - Windows/Linux versions
  - User utilities and post-processing/visualization capabilities
  - Extensive code documentation



MELCOR RCIC System Modeling & Analysis

- Previous work added mechanistic RCIC models to MELCOR (2015-2017)
  - Homologous pump model
  - Terry turbine pressure and velocity stage models
  - Rigid shaft model (torque-inertia equation)
  - Miscellaneous features including optional sub-models that facilitate use of Texas A&M experimental data
    - Extra user-specified turbine and pump torque terms (control function capability)
    - Sensitivity coefficients for windage torque and driving torque multiplier
    - Turbine-only operation mode (no pump coupling)

- Current work focuses on the use and implementation of mechanistic RCIC models
  - Generic BWR demonstration input deck to show:
    - MELCOR capabilities for modeling RCIC intervention in one or more selected severe accident scenarios
    - MELCOR as a tool for risk-informed decision making within the context of PRA, SA, and/or UQ type studies
  - Support for Texas A&M University experimental program
    - MELCOR models of experimental facilities (e.g. GS-2 air facility, ZS-1 turbine/dynamometer facility)
    - Consultation with Texas A&M Nuclear Heat Transfer Systems Lab for ongoing experimental program

MELCOR RCIC System Modeling & Analysis

- Generic BWR demonstration input deck modeling goals include:
  - Demonstration of systems-level RCIC model configuration and operation for users' benefit
  - Learning lessons about code performance, system response, and accident progression
  - Production of a generally useful end product for the MELCOR user base (regulators, academia, industry)
- Primary modeling emphasis: capture thermal-hydraulic response of the RCIC turbopump system
  - Start with a scram and 2-hr run-up to DC power loss
  - Eventually, RCIC enters a self-regulating mode
    - Initial over-speed when governor valve goes full-open
    - Self-regulation observed (without over-speed) thereafter
- To investigate moving forward:
  - Model sensitivities
  - Types/forms of turbine losses (experimental insights)
  - High-consequence, low-knowledge parameters