Probabilistic Risk Assessment (PRA) Presentation to Study Tour for Chinese PUNT Delegation

May 14, 2007
Timothy Wheeler – PMTS
Sandia National Laboratories

Sandia has a long history in reactor safety research and development

- Sandia has supported the US Nuclear Regulatory Commission through regulatory research for 30 years

- The historical focus has been on safety of the current US power reactor reactors

- Future work for the NRC will have three main thrusts:
  1. Safety of the existing reactors
  2. Licensing support for new light-water reactors in the near-term
  3. Research and Development on safety issues for advanced reactor designs

- Sandia will also support the safety element of DOE's Global Nuclear Energy Partnership Program
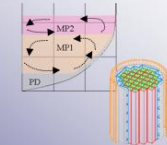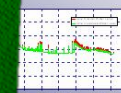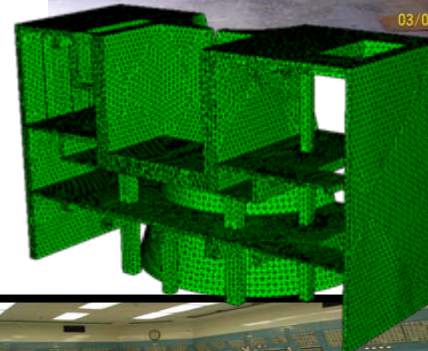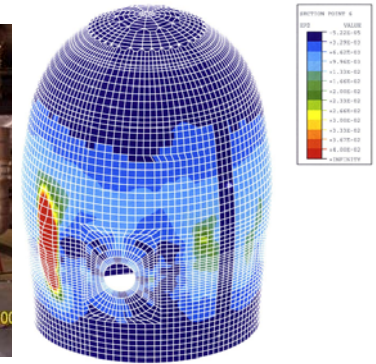
U. S. Nuclear Regulatory Commission Programs

SNL supports the USNRC mission through advanced modeling, testing, and analyses

- **Focus areas**
  - **Risk-Informed Regulation**
    - Probabilistic risk assessment
    - Fire protection
    - Human reliability analysis
  - **Severe Accident Modeling**
  - **Security Assessments**
  - **Experiments and Structural Analyses**

MELCOR 1.8.6

A Computer Code for Analyzing Severe Accidents in Nuclear Power Plants and Other Facilities

The MELCOR code is developed at Sandia National Laboratories for the United States Nuclear Regulatory Commission

Spent Fuel Pool

Sandia National Laboratories
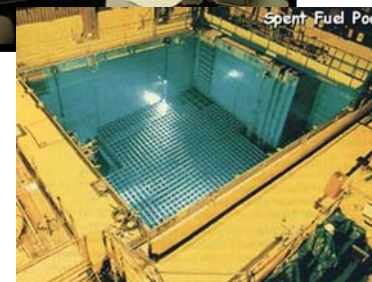
Risk-Informed Regulation

- *<u>Description</u>*

- **Based on 25 years of leadership in PRA and safety technology development**

- **A balance of deterministic and probabilistic approaches to:**

  - **<u>Enhance safety</u> by focusing resources**

  - **<u>Provide a framework</u> to support regulatory decisions**

  - **<u>Allow flexibility</u> in plant operation and design**

- **Leads to *safer,* more effective regulation**

- **Based on Quantitative Safety Goals and a PRA Policy Statement**

Sandia National Laboratories

Probabilistic Risk Assessment is a key input to Risk-Informed Regulation

Sandia is prominent in major PRA studies sponsored by the NRC including:

– RSSMAP, IREP, NUREG-1150, RMIEP, Low Power Shut Down, Fire Risk Scoping Study

SNL also has contributed to major PRA application studies:

– Pressurized Thermal Shock, Combustible Gas Control, Decay heat Removal, Station Blackout Study
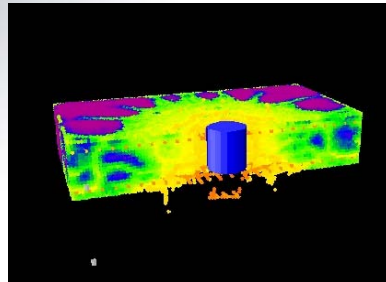
PRA Models
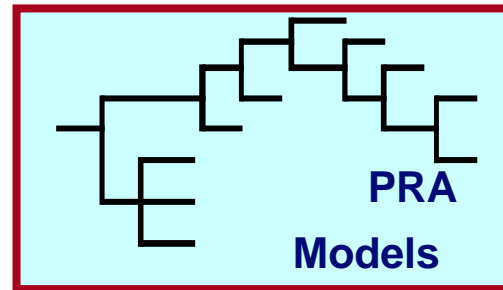
SNL has supported development and application of PRA licensing evaluation tools

– Accident Sequence Precursor evaluations
– Significant Determination Process model development
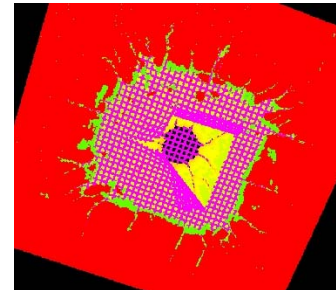– Generic Safety Issue evaluation

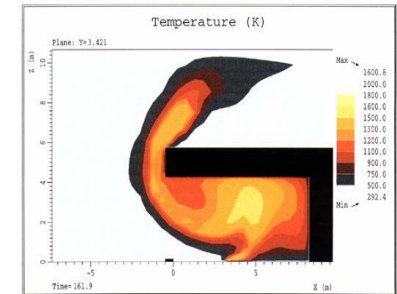# PRA integrates the various aspects of severe accident analysis
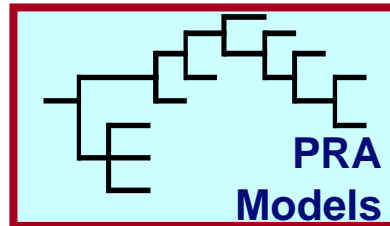
Computing

Penetration & Structures

Explosives

Fire

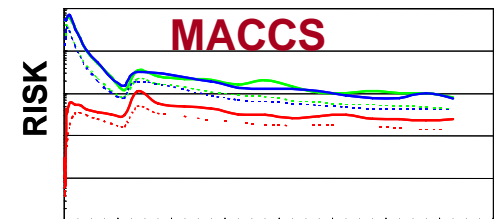**Nuclear Reactor Safety**

PRA Models

Plant Responses

MELCOR

Release Fraction / Time [hr]
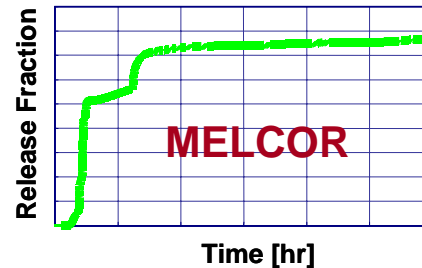
Radiation Release

MACCS

RISK / DISTANCE

Health Effects

Testing

Sled Track

Fire

Structures

Sandia National Laboratories

Sandia-developed codes MELCOR and MACCS are the premier computer tools for modeling nuclear power plant accident progression and consequences, world-wide.

Fire Protection and Risk

SNL is at the forefront of fire risk methods development and application
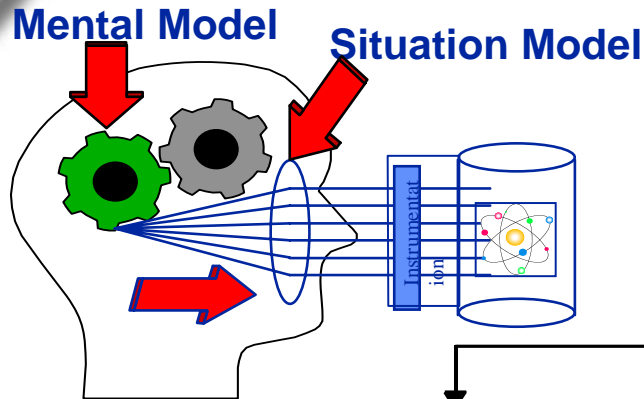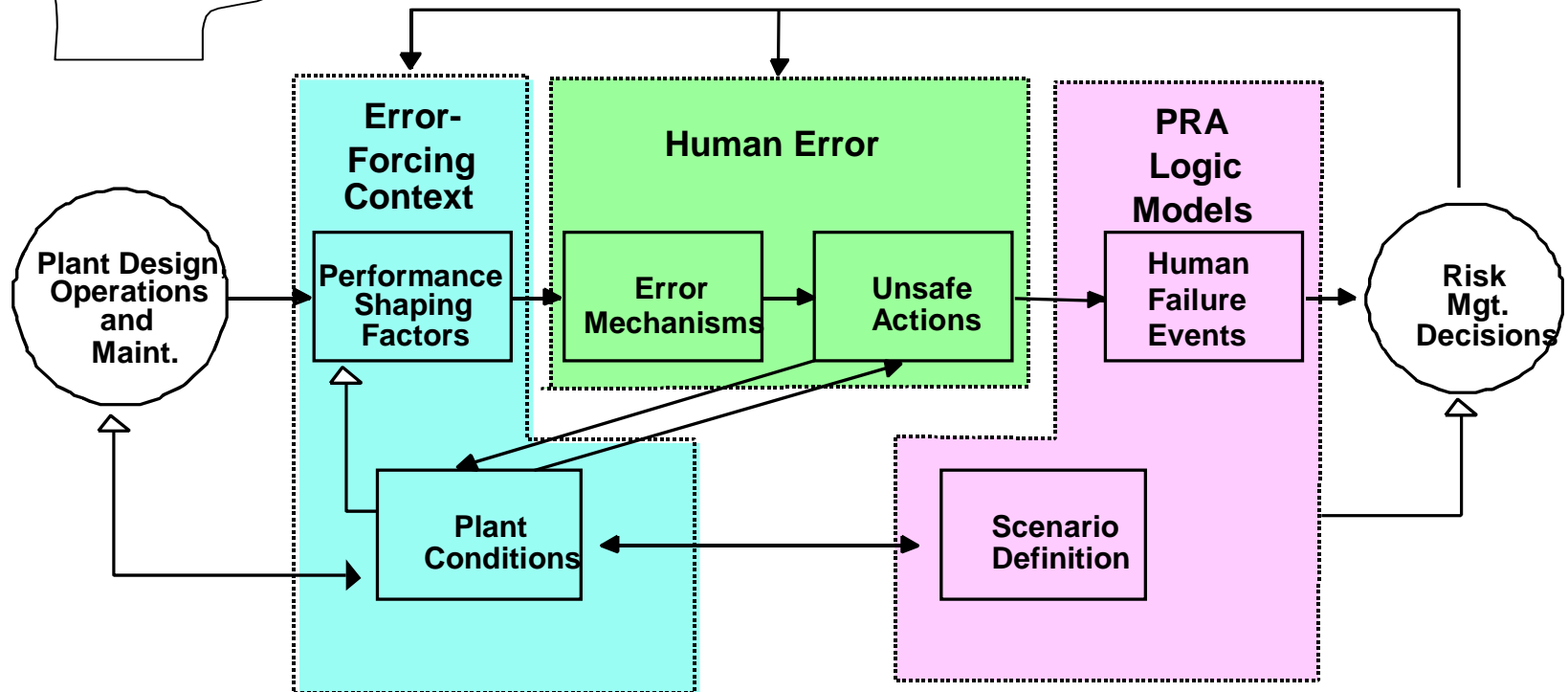
Steve Nowlen will present more

Fire Protection
- Inspections
- NFPA 805
- Fire Protection SDP
- Cable Fire Testing
- Hemyc and MT fire barrier tests

Advanced Human Reliability Analysis Techniques

Mental Model

Situation Model

A systematic process for evaluating human errors of commission

Instrumentation

Error-Forcing Context	Human Error	PRA Logic Models

Plant Design Operations and Maint.

Performance Shaping Factors

Error Mechanisms

Unsafe Actions

Human Failure Events

Risk Mgt. Decisions

Plant Conditions

Scenario Definition

The *ATHEANA* HRA Process

Sandia National Laboratories

Experiments and Structural Programs

- **Nuclear power plant containment: experimental and modeling programs**
- **Seismic analyses of transportation/storage casks**
- **Analysis of Oyster Creek drywell corrosion for license renewal**
- **Spent fuel pool thermal experiments**
- **Dispersal of spent nuclear fuel experiments**
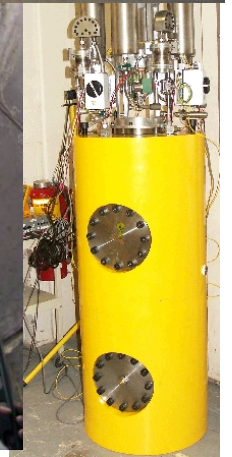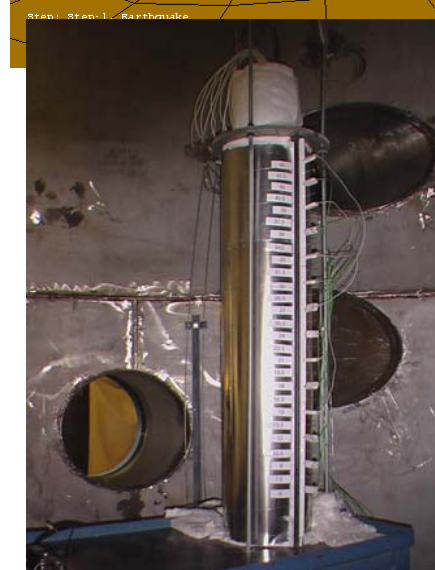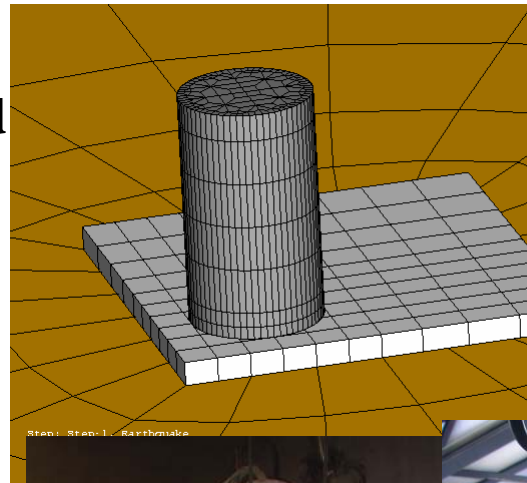
Sandia National Laboratories

- **Support for new reactor licensing**
  - **First Combined Operating Licenses for advanced LWR designs expected in late 2007, with many more to follow**
- **Support for licensing of advanced non-light-water reactors**
- **Global Nuclear Energy Partnership: safety and licensing are of critical importance**
- **Continue to support NRC in regulatory research and security areas**

Sandia
National
Laboratories