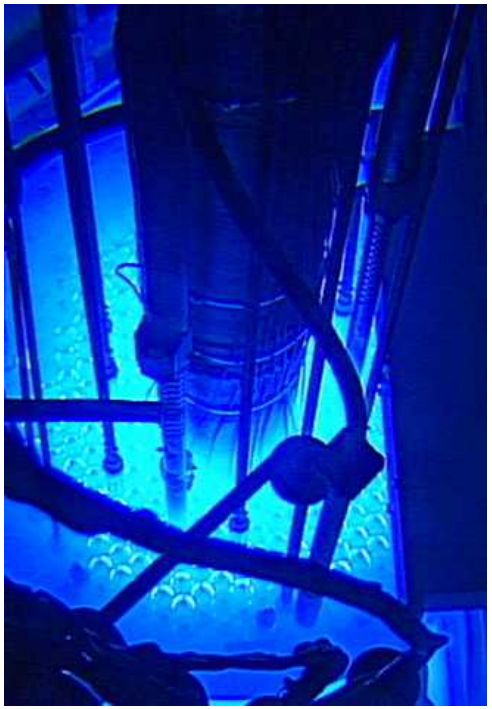
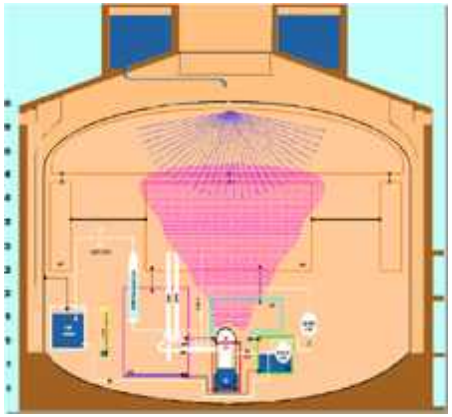
Nuclear Reactor Safety, Security, and Reliability (Surety) Overview

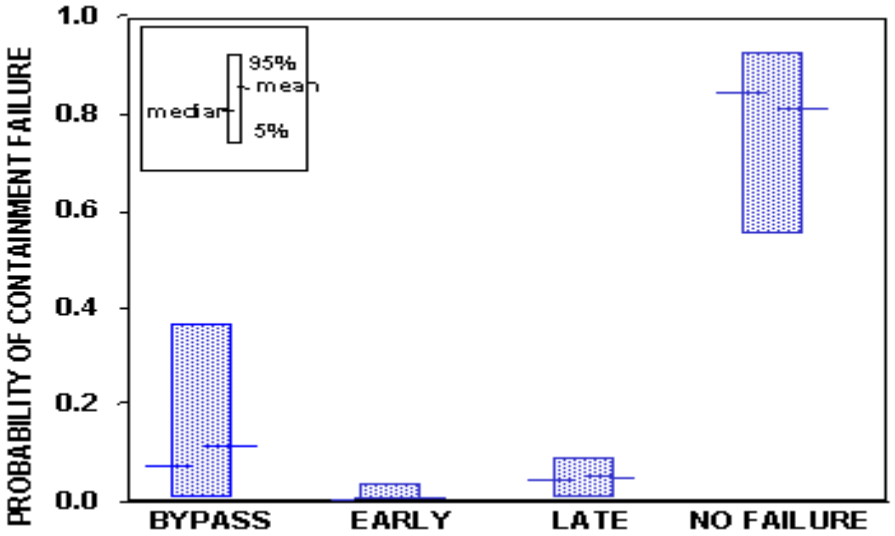
SAND2008-1201P



Joe Harris
Deputy Director
Manufacturing Science and Technology
Sandia National Laboratories

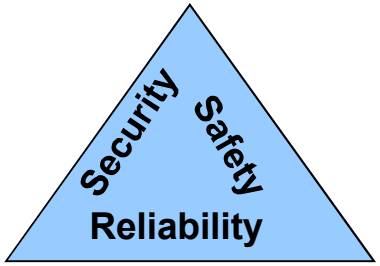
Nuclear Reactor Surety



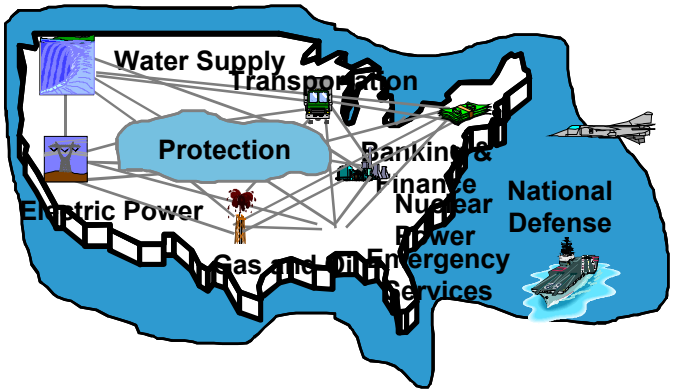


Introduction

Reactor Surety

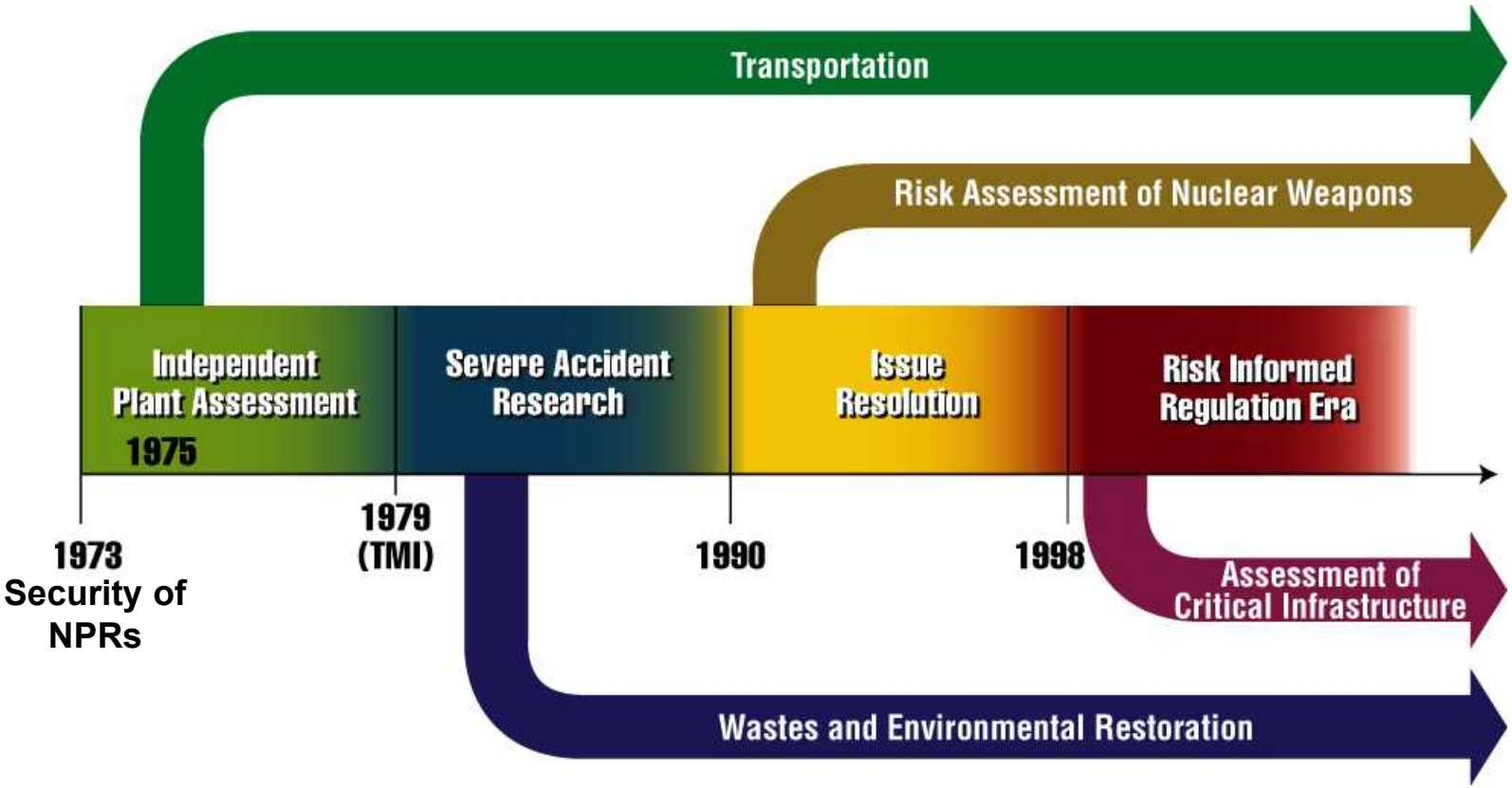


Surety



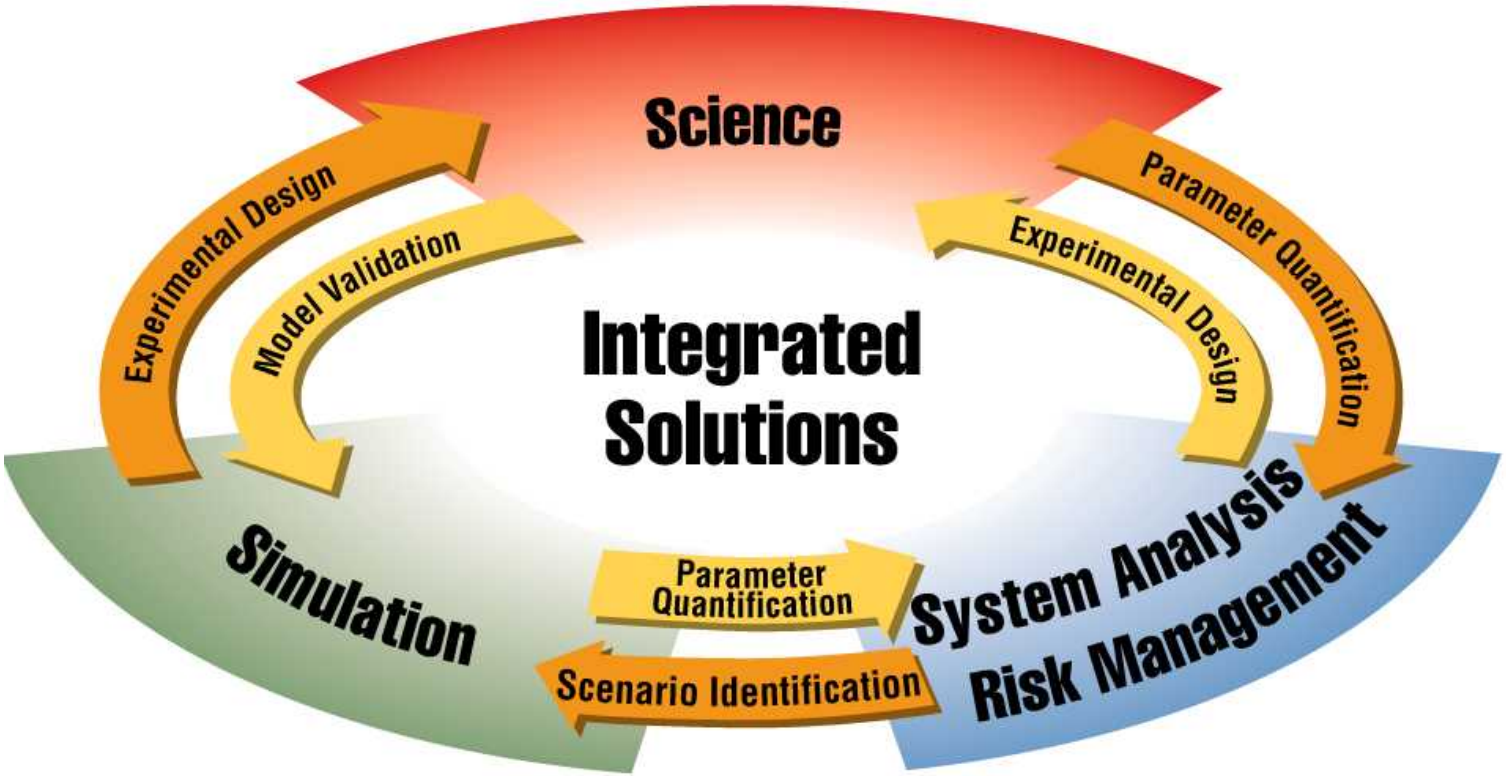
- 25 years experience in developing safety and reliability methods
- Used an integrated approach to resolve nuclear reactor surety issues.
- Same approach using similar methods are being applied to other national issues (e.g. Infrastructure Surety)

History of Nuclear Reactor Surety and Spin-off Applications

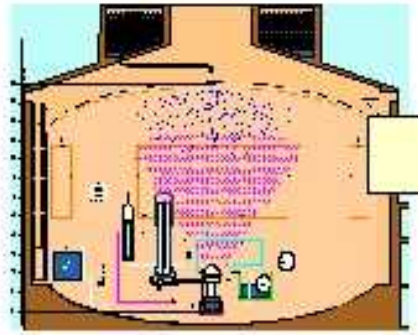


Timeline

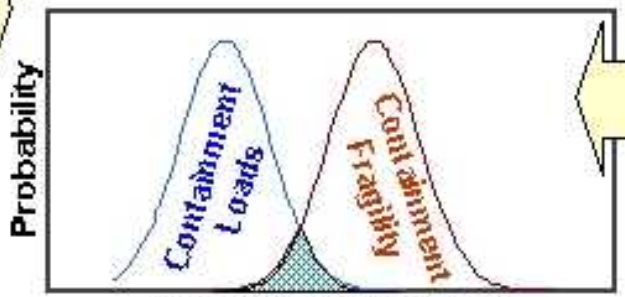
Integrated Approach to Nuclear Reactor Surety



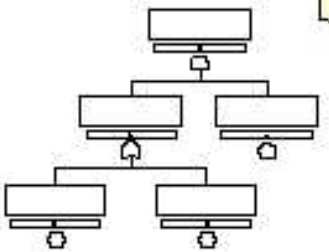
System Analysis & Risk Integration



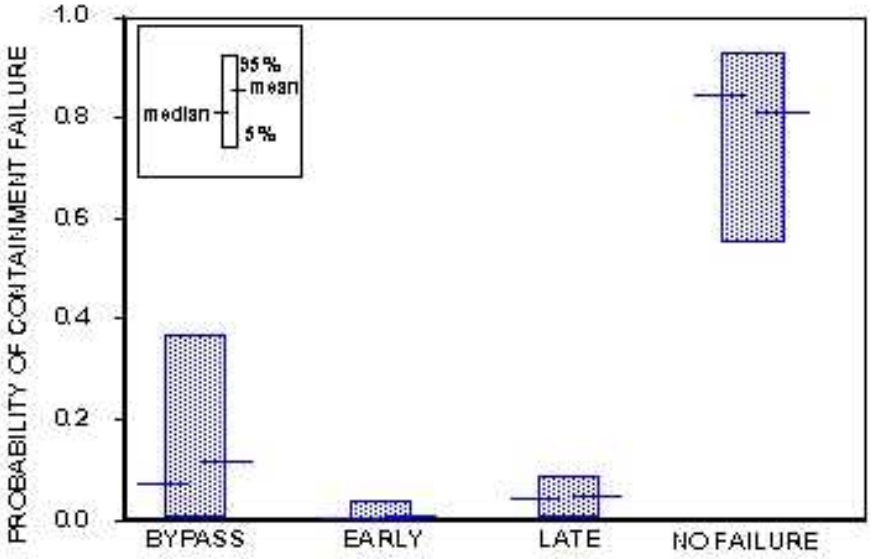
Modeling & Simulation



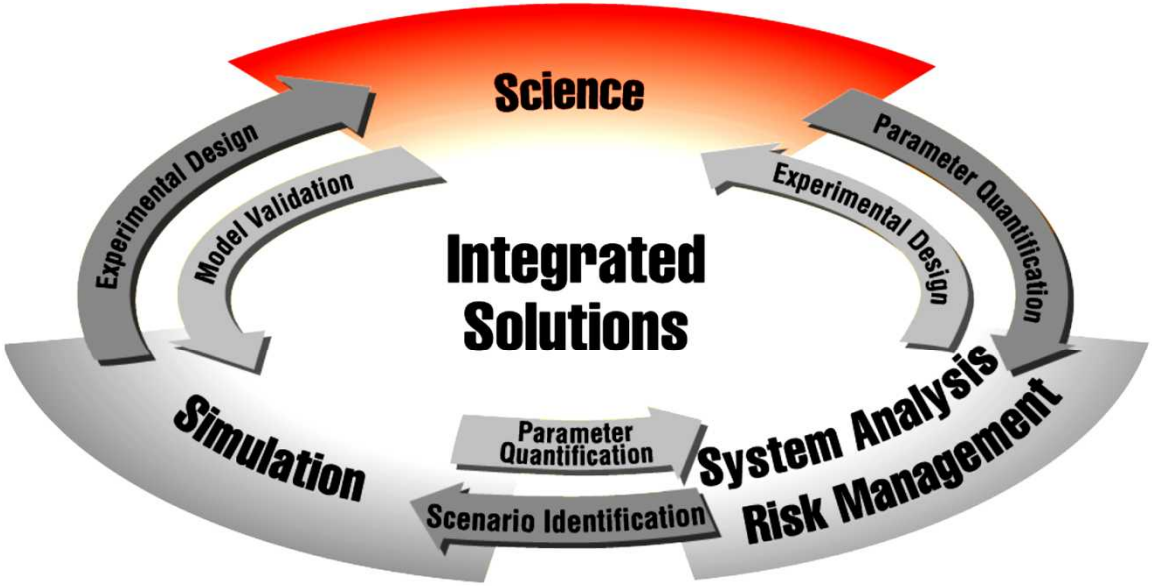
Experiments



Risk Integration



Reactor Safety Experiments



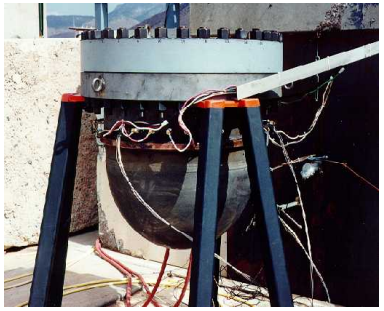
Objectives

- Directly Resolve Issues
- Assess, Validate, and Develop Models
- Quantify Parameters and their Uncertainties

Broad-reaching Experimental Capabilities

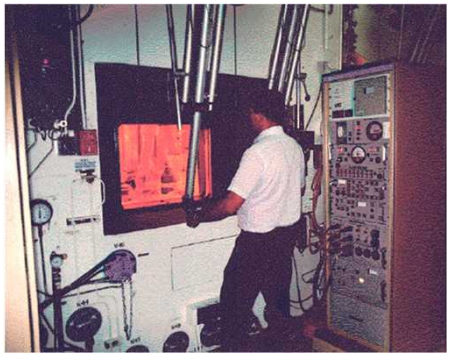
Large scale facilities used to generate realistic representations of complex phenomena and processes

Annular Core Research Reactor (ACRR)



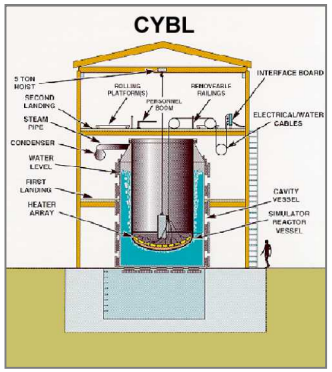
Lower Head Failure Test at Explosive Dynamics Laboratory

Surtsey Test Facility



Hot Cell Facility

Containment Technology Test Facility (CTTF)



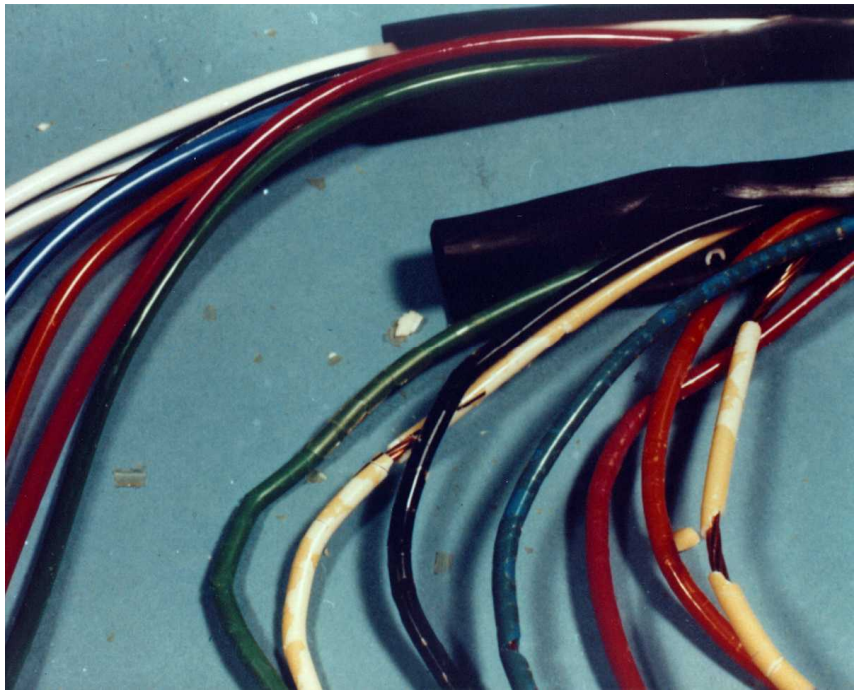
CYBL Facility

Large Melt Facility (LMF)

Explosive Firing Site

Cable Aging

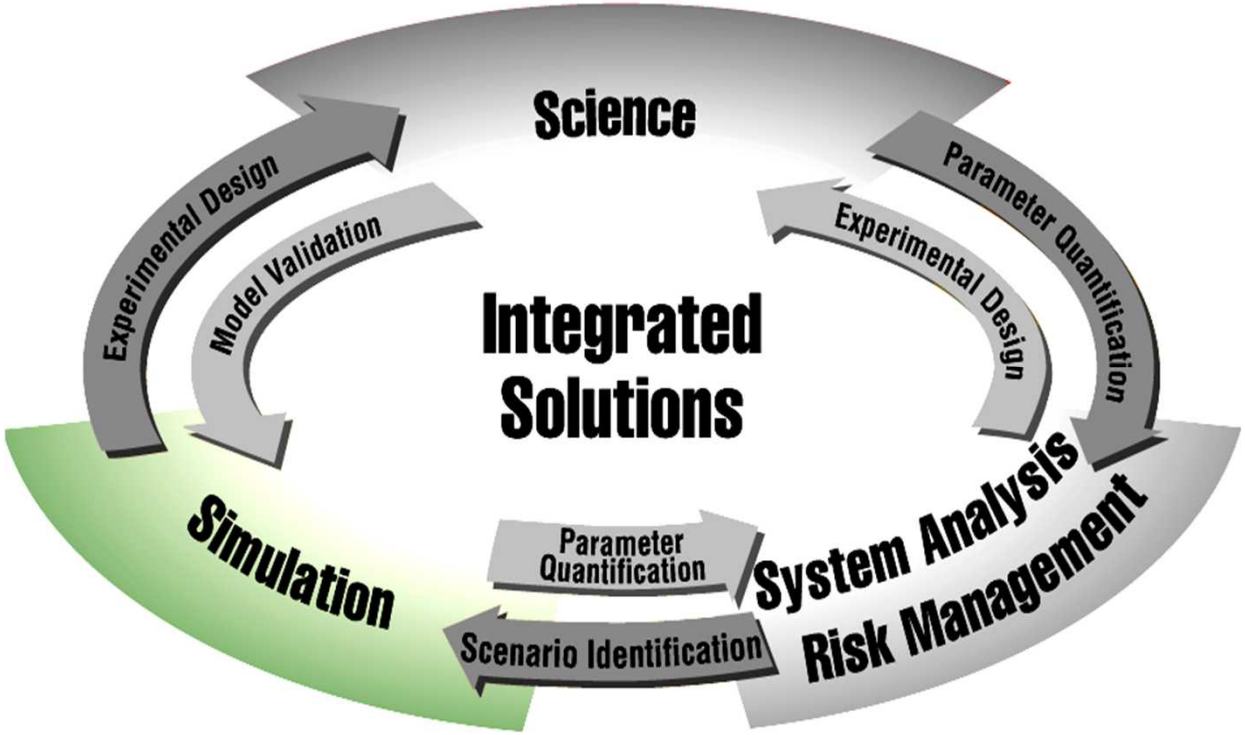
Cable Life Assessment and Condition Monitoring -- Tools to Ensure High Reliability Cable Systems



New and Aged Cables From Savannah River

- Commercial Nuclear Power Plants
  - Predict and Detect Degradation
  - Satisfy Regulatory Requirements
  - Transfer Technology
  - $80+M/Plant to Replace Cables
- Other Applications
  - Aircraft
  - High Consequence Installations
- Sandia's New Concepts:
  - Science-Based Methods to Predict
  - Aging in Combined Environments
  - Studies of Naturally-Aged Cables
  - NDE to Assess Cable Condition

Modeling and Simulation

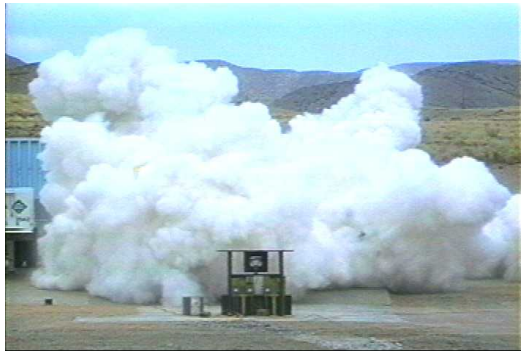


Objectives

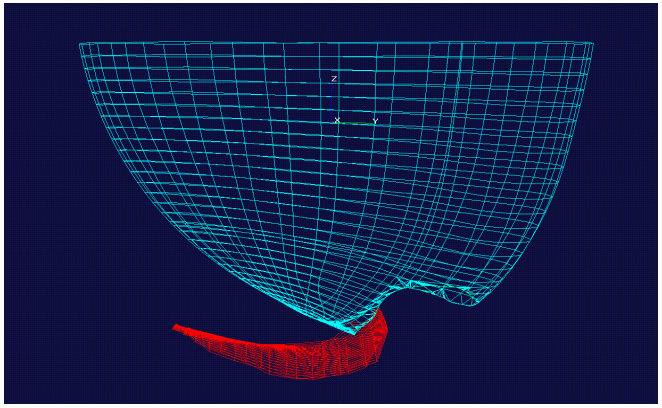
- **Develop and Validate Models to:**
  - **Resolve Regulatory Issues**
  - **Perform Plant Calculations**
  - **Design Experiments**

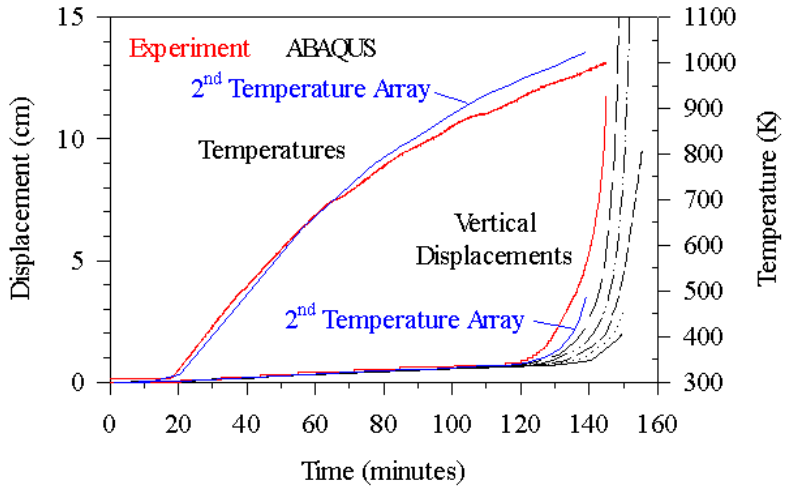
Model Validation Methodology

Experiments Designed to Capture Key Data with Well Defined Initial and Boundary Conditions



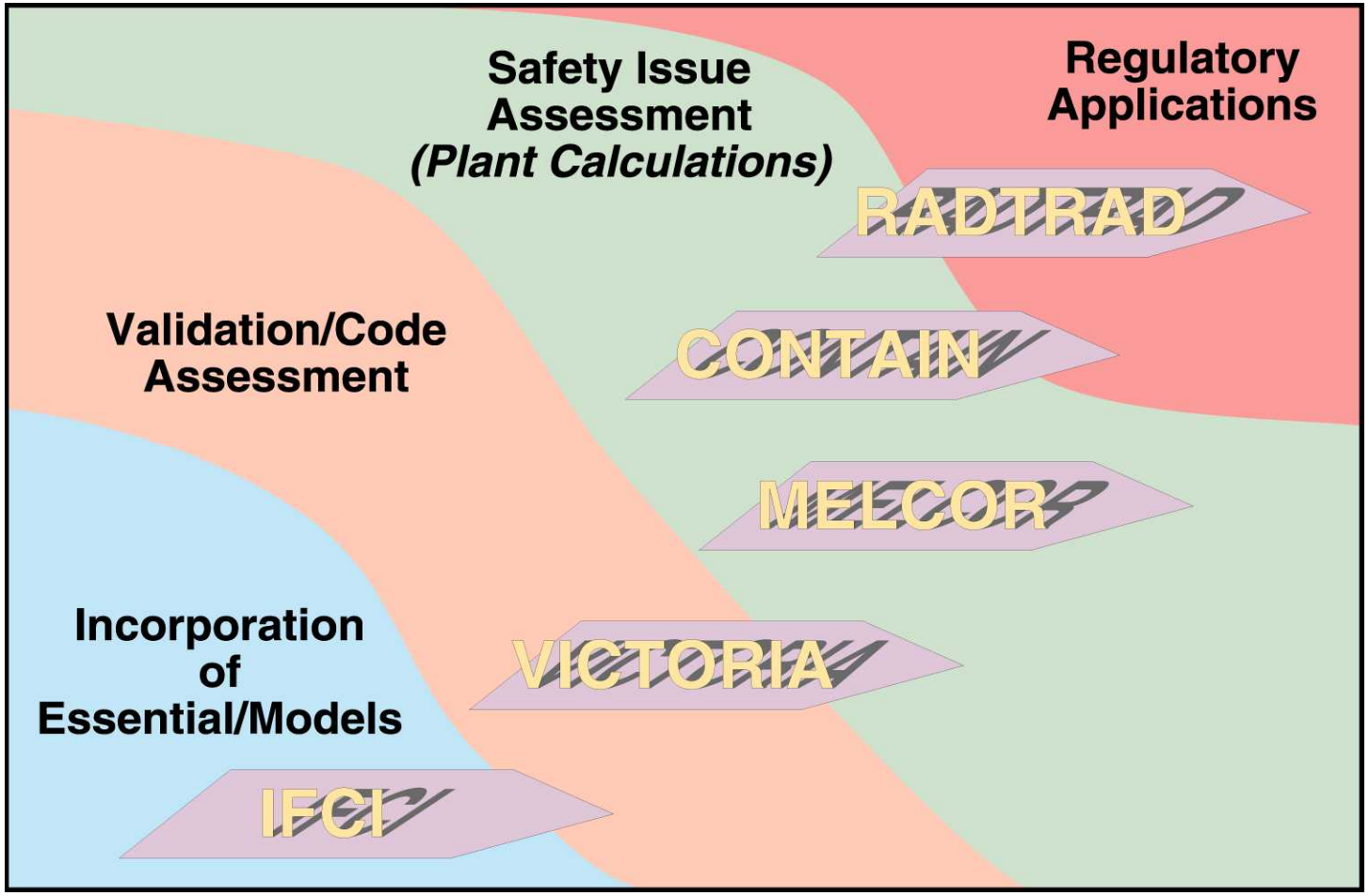
Code Validation through Detailed Comparison With Measured Data





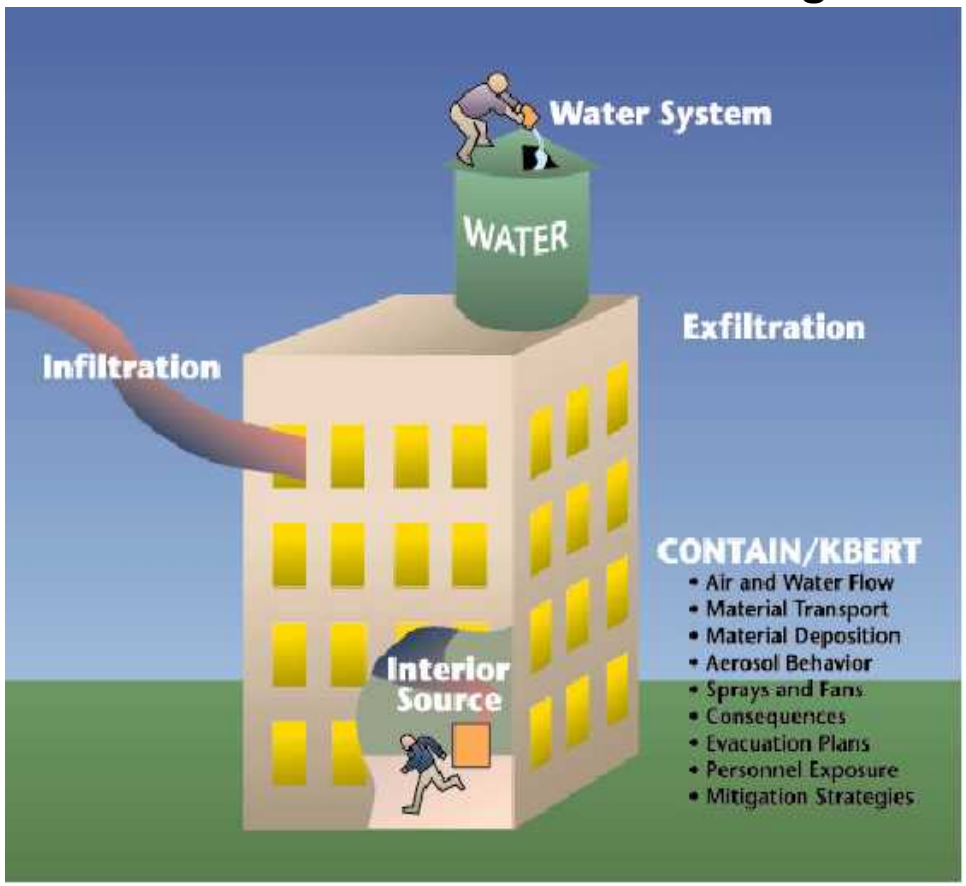
Sandia is the USNRC's Resource for Accident Codes

Each application addresses different problems. Some codes focus on specific phenomena and others take an integrated approach.



CONTAIN/KBERT

A validated, flexible code for analyzing chem-bio attacks on buildings and facilities



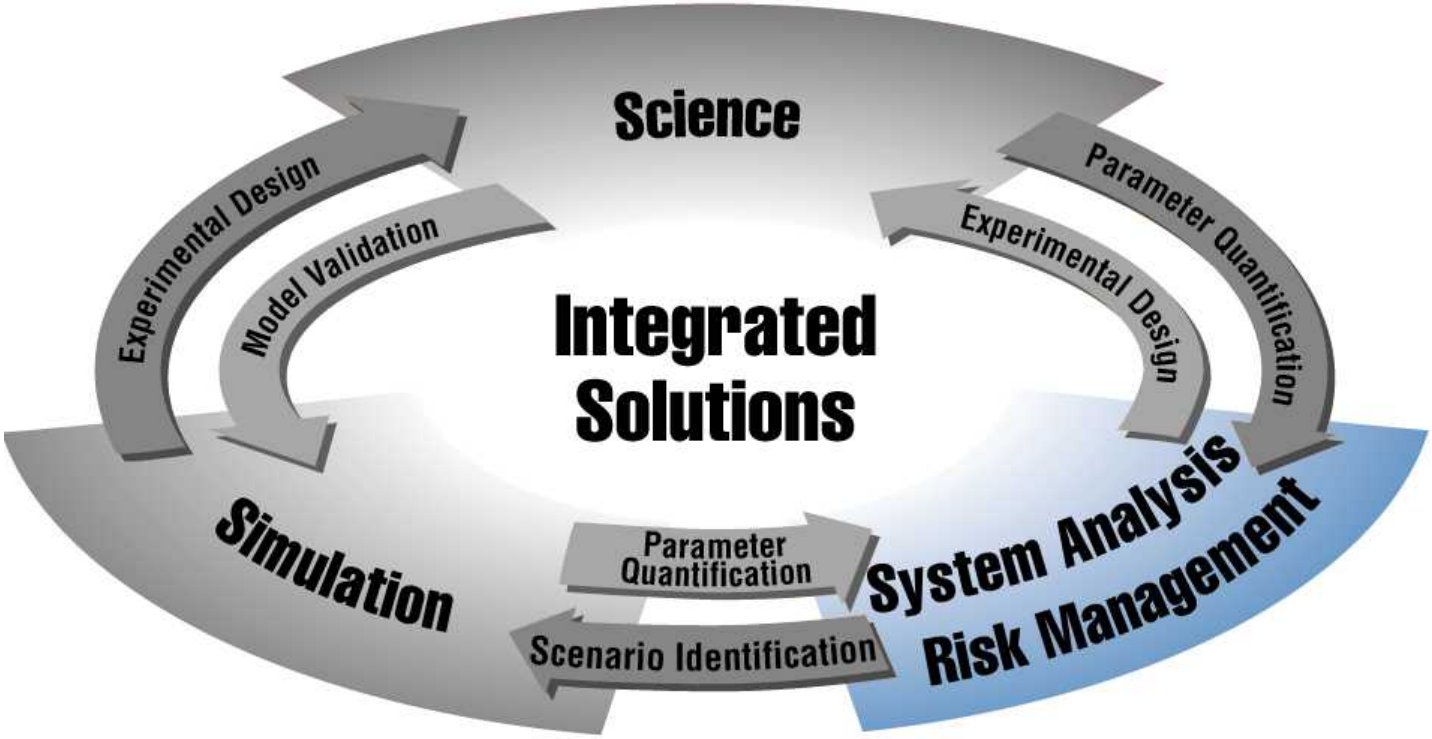
Background

Deliberate introduction of chemical, biological and radioactive materials into critical facilities.

Benefits

CONTAIN is the USNRC's principal tool for analyzing accident conditions in nuclear containments.

Systems Analysis and Risk Management

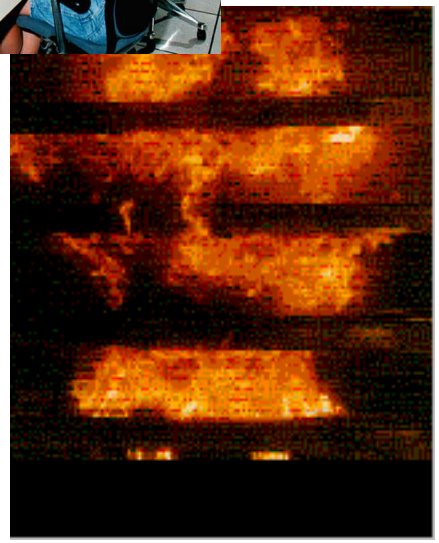


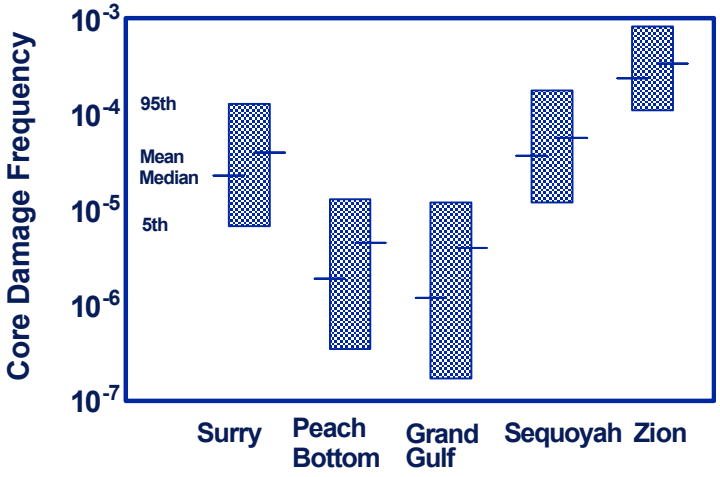
Objectives

- Integrate experimental and simulation results with system models to provide a comprehensive treatment of hazards and failures.
- Provide decision support accounting for uncertainties

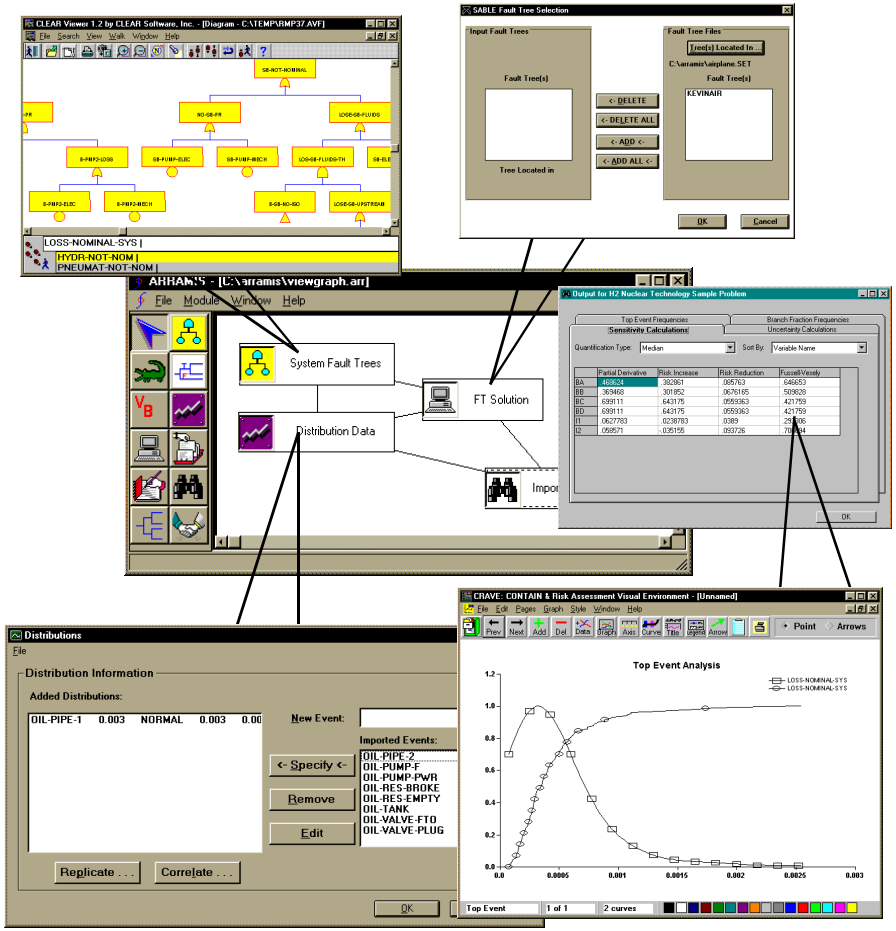
Comprehensive Risk Assessment

- System and Component Reliability
- Advance Human Reliability Analysis Techniques
- Improved Fire Risk Assessment Methods
- Advance Uncertainty Analysis Techniques
- Integrated Risk Assessment for 5 NPPs
- Individual Plant Examinations





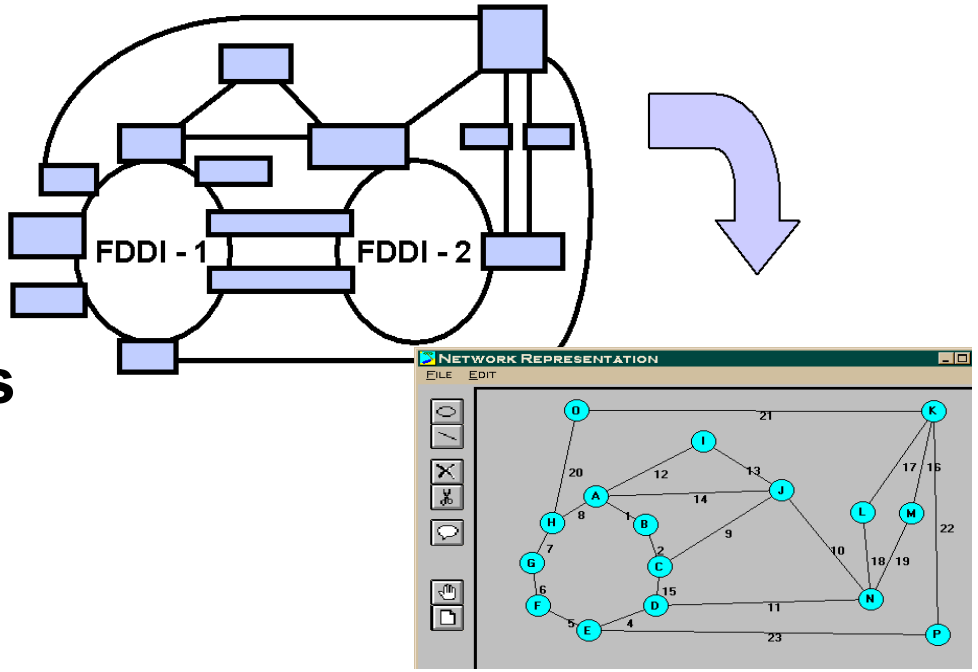
Risk Assessment Methods



- Advanced risk assessment tools and software adopted throughout the risk community
- Risk Assessment “Standard” for NPPs

Adaptable to Other Applications

Methods extended to address arbitrarily connected communication networks



ARRAMIS™ code suite developed for weapon risk assessment