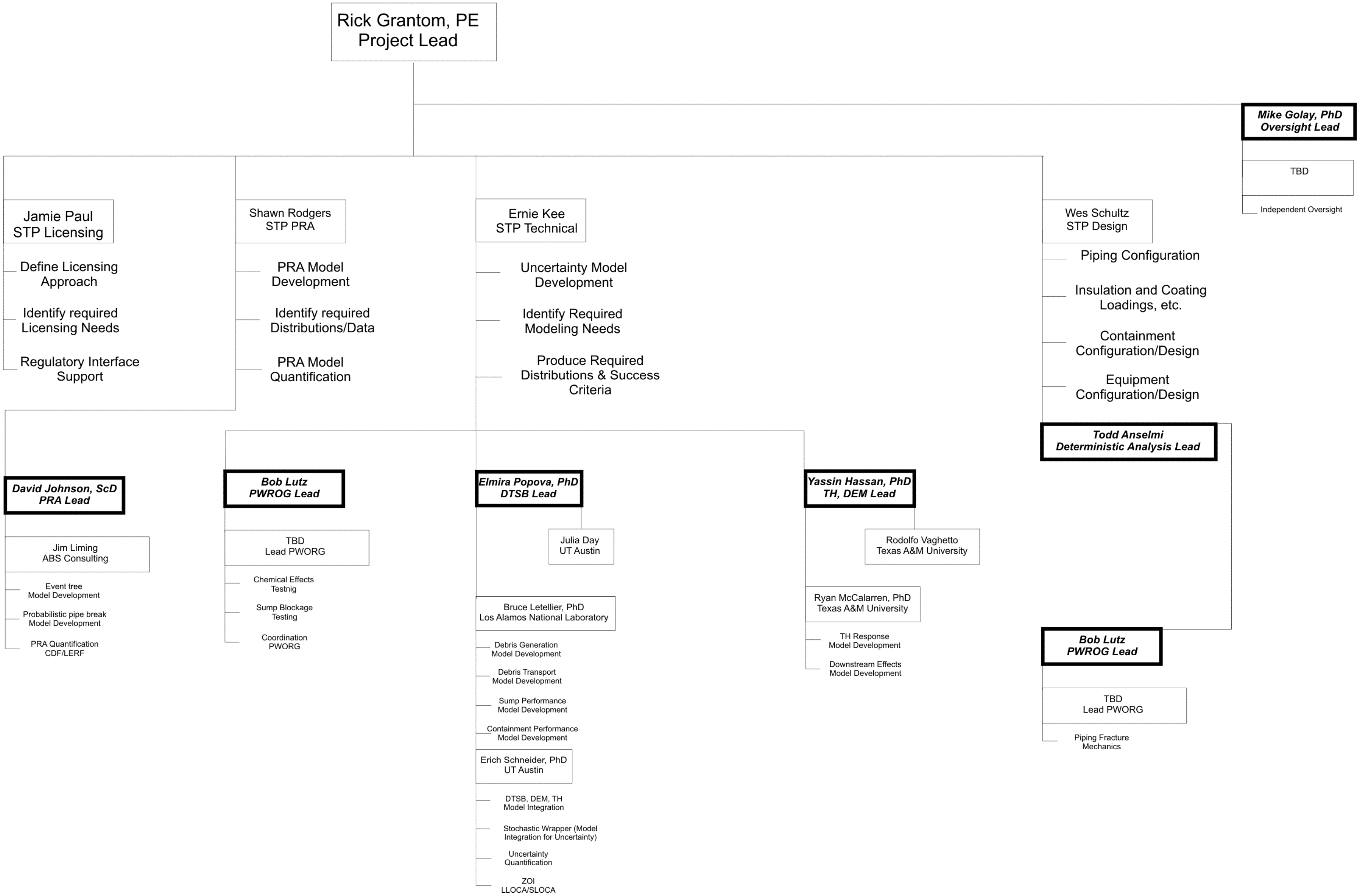
Risk Informed GSI-191
NRC Kick-Off Meeting

NRC Public Meeting
February 22, 2011

South Texas Project
C. Rick Grantom P.E.
Project Manager

Kick-Off Meeting Desired Outcomes

- Gain alignment and better understanding with NRC on risk informed approach
- Overview the technical models that will be used in performing the risk informed approach
- Establish NRC points of contact for performing necessary reviews
- Establish next steps for pilot designation
- Establish communication & milestone plan



Rick Grantom, PE
Project Lead

- **Mike Golay, PhD** — *Oversight Lead*
  - TBD
    - Independent Oversight
- Jamie Paul — STP Licensing
  - Define Licensing Approach
  - Identify required Licensing Needs
  - Regulatory Interface Support
- Shawn Rodgers — STP PRA
  - PRA Model Development
  - Identify required Distributions/Data
  - PRA Model Quantification
  - **David Johnson, ScD** — *PRA Lead*
    - Jim Liming — ABS Consulting
      - Event tree Model Development
      - Probabilistic pipe break Model Development
      - PRA Quantification CDF/LERF
- Ernie Kee — STP Technical
  - Uncertainty Model Development
  - Identify Required Modeling Needs
  - Produce Required Distributions & Success Criteria
  - **Bob Lutz** — *PWROG Lead*
    - TBD — Lead PWORG
      - Chemical Effects Testnig
      - Sump Blockage Testing
      - Coordination PWORG
  - **Elmira Popova, PhD** — *DTSB Lead*
    - Julia Day — UT Austin
    - Bruce Letellier, PhD — Los Alamos National Laboratory
      - Debris Generation Model Development
      - Debris Transport Model Development
      - Sump Performance Model Development
      - Containment Performance Model Development
    - Erich Schneider, PhD — UT Austin
      - DTSB, DEM, TH Model Integration
      - Stochastic Wrapper (Model Integration for Uncertainty)
      - Uncertainty Quantification
      - ZOI LLOCA/SLOCA
  - **Yassin Hassan, PhD** — *TH, DEM Lead*
    - Rodolfo Vaghetto — Texas A&M University
    - Ryan McCalarren, PhD — Texas A&M University
      - TH Response Model Development
      - Downstream Effects Model Development
- Wes Schultz — STP Design
  - Piping Configuration
  - Insulation and Coating Loadings, etc.
  - Containment Configuration/Design
  - Equipment Configuration/Design
  - **Todd Anselmi** — *Deterministic Analysis Lead*
    - **Bob Lutz** — *PWROG Lead*
      - TBD — Lead PWORG
        - Piping Fracture Mechanics

Team Assignments

- Texas A&M
  - RCS full-power simulation and transient system response (boundary conditions for break simulation)
  - Fuel temp parameterizations
- University of Texas
  - Uncertainty Quantification (break frequency, etc)
  - Sampling and propagation strategies (CASA Grande)
  - Break Zone Simulation (CTH)
  - Pool velocity simulation (if needed)

Team Assignments

- Los Alamos National Laboratory
  - Containment response (if needed)
  - Sump screen performance
  - Develop CASA Grande analysis tool
- ABS
  - PRA modification and evaluation
  - Consultation regarding Risk-Informed implications
- Massachusetts Institute of Technology
  - Internal review of PRA and accident seq interface

Team Assignments

- Alion
  - As-built CAD
  - Compilation of test data report
  - Consultation on debris transport and sump performance
- STP
  - Plant data interface
  - Licensing strategy
  - Project management
  - Plant operations configuration and flexibility

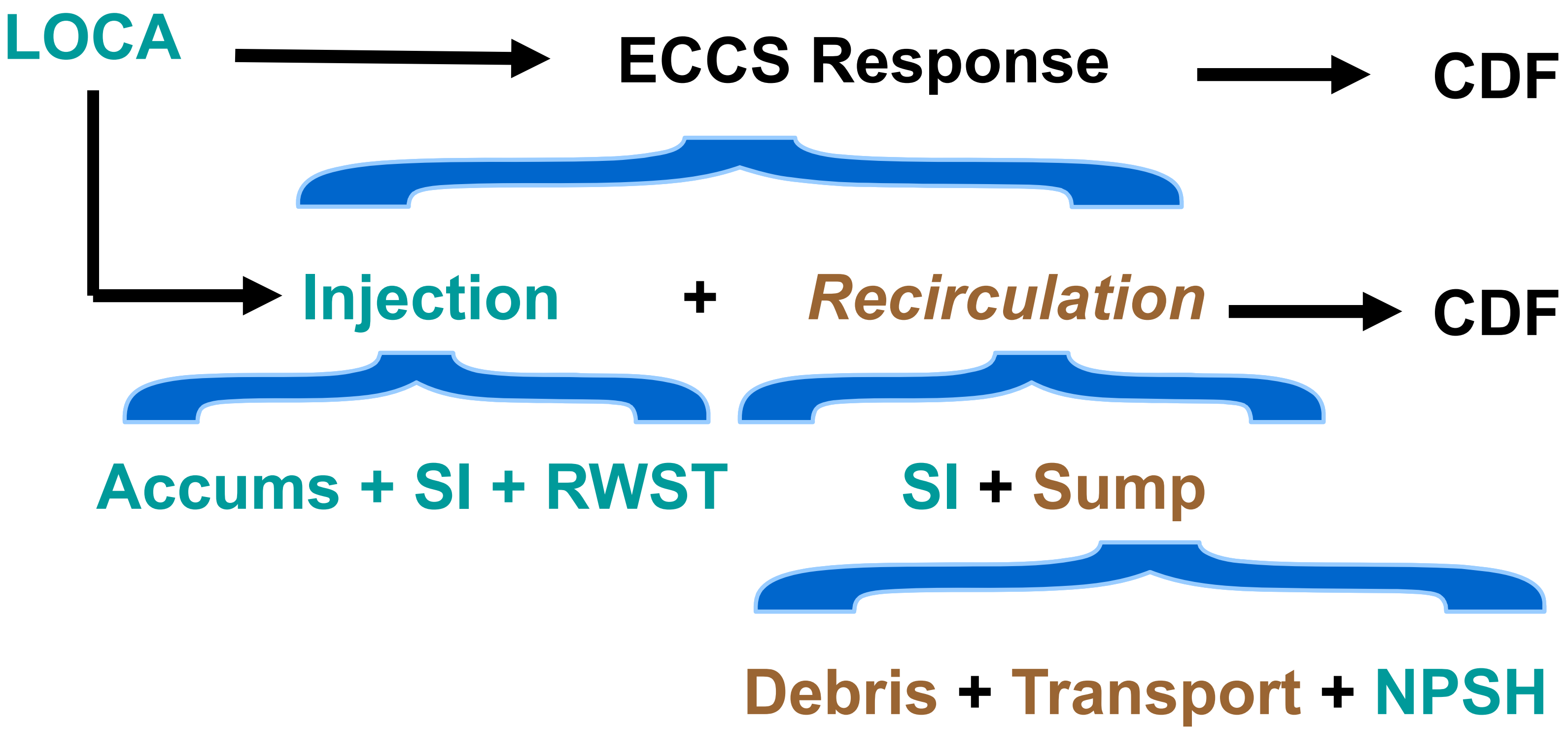
Technical Analyses Overview

Deterministic Evaluation Attributes	Probabilistic Evaluation Attributes
Predetermined scenarios are analyzed assumed to be “worst case”.	Full spectrum of scenarios is analyzed that covers wider range of possibilities. There is solid evidence in the scientific literature that probability is the best measure of uncertainty.
Decision-making is “absolute” - no uncertainty in the decision-making process.	Uncertainty is integral to decision-making. Risk-based methods quantify both the uncertainty of the state of our knowledge and the variability in physical phenomena.
Need for detailed analysis and full phenomenology understanding is avoided by assuming “conservative” values for parameters.	Detailed modeling and analysis is needed to properly characterize uncertainty.

Primary Project Objectives

- Obtain core damage frequency distribution for hypothesized LOCAs that require ECCS recirculation.
- Compare core damage frequency & large, early release frequency results for Potentially Sump Blocking Insulation & Non-Sump Blocking Insulation designs against the criteria of RG1.174
- Employ RG 1.174 strategy to provide risk informed closure of GSI-191
- Finalize plan for GSI-191 closure by mid 2012 for STP
- Develop a repeatable risk informed GSI-191 Closure Method

PRA Perspective



LOCA → ECCS Response → CDF

LOCA → Injection + *Recirculation* → CDF

Accums + SI + RWST

SI + Sump

Debris + Transport + NPSH

🟦 Documented probabilistic basis for risk quantifications

🟫 Area of uncertainty, need probabilistic distributions and commensurate technical basis

Technical Overview

- The risk-informed approach to GSI-191 closure requires development and integration of five major elements. Each of these elements has one or more technically challenging subtasks.
  - **DTSB**: generation and transport of debris to the sump. Resulting sump differential pressure
  - **TH**: RCS thermal-hydraulic response.
  - **DEM**: Downstream effects of debris getting through the sump screens and into the core, SI components.
  - **PRA**: A logic model that develops and quantifies the scenarios leading to core damage.
  - **Uncertainty Quantification (UQ)**: The propagation of uncertainty in the physics-based models, analysis of existing experimental data, expert elicitation, and formation of the input needed by the PRA.

Multiple Physics Models

Reactor TH
Plant State Point
Internal Obstructions
Transient Blow Down
EOP Response

ZOI Formation
Probability of Break
Fracture Mechanics
Jet Expansion
Jet Reflection
Break Location

Containment
Blow Down Transport
Spray Actuation
Environment P&T
Wash Down Transport

Sump Pool
Debris Transport
Debris Degradation
Chemical Product Formation
Temperature History

Sump Screen
Debris Accumulation
Thin-Bed Formation
Screen Penetration
Face Velocity
Porous Media Head Loss
$NPSH_{Margin}$

Injection Systems
Recirculation Demand
$NPSH_{reqd}$
Degraded Pump Performance
Valve Wear
Operability

Plant PRA
LOCA Probability by Size/System
Probable Loss of Recirculation
CDF and LERF

PRA Model Overview

Overview of Approach

David Johnson

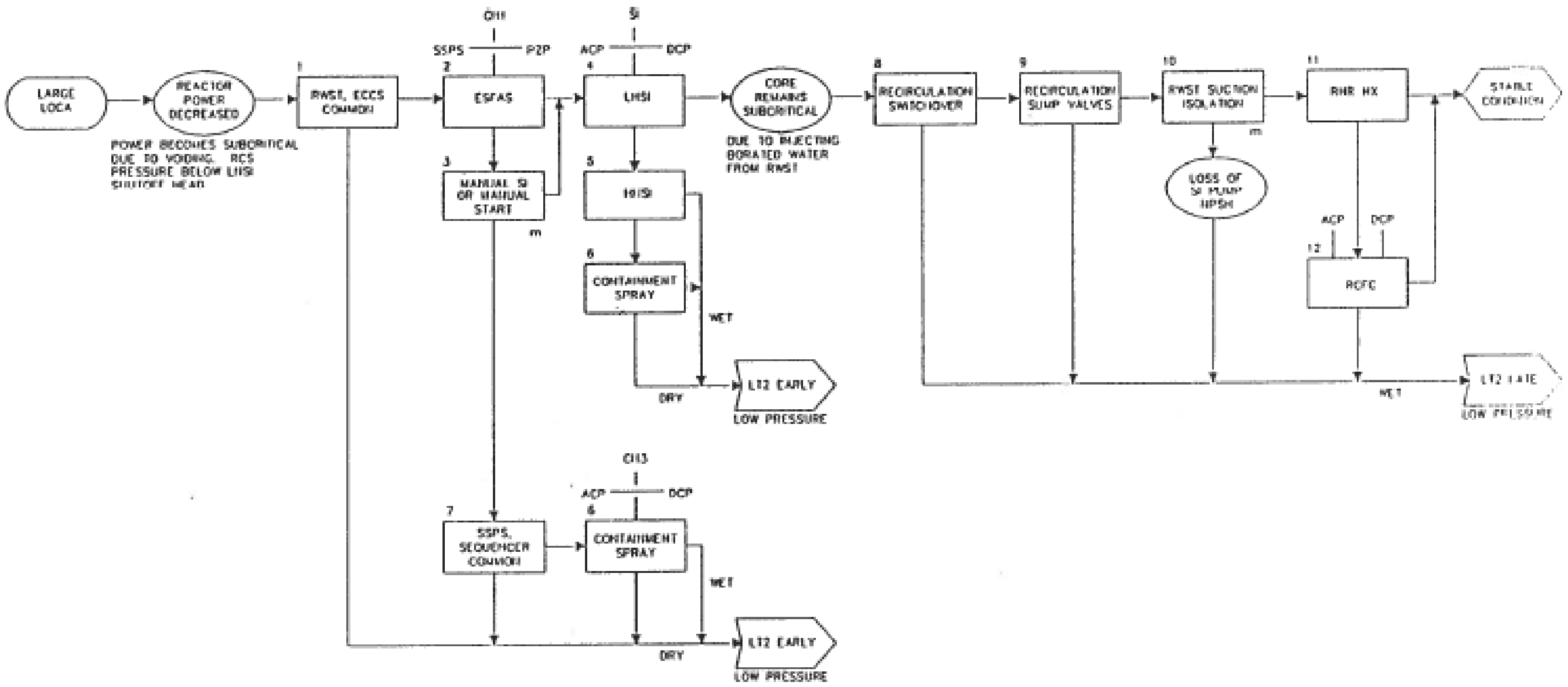
ABS Consulting Inc

ABS Consulting
AN ABS GROUP COMPANY

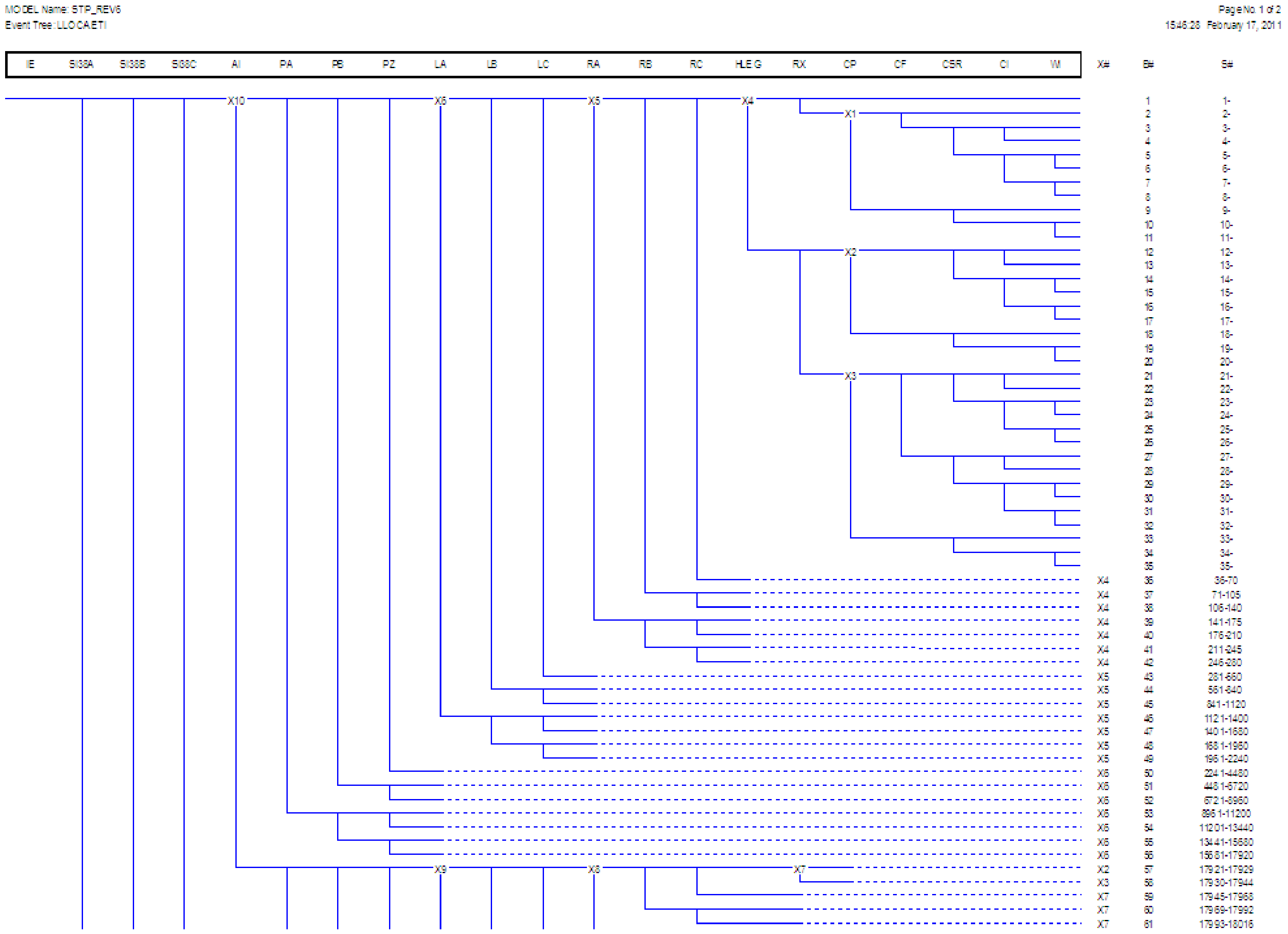
Near term PRA Activities

- Develop expanded LOCA Event Trees
  - Detailed sequence of events associated with potential sump performance phenomena
  - Develop necessary logic structures to represent results from other team members
  - Support uncertainty calculation
- Integration of New Analyses
  - Utilize analyses from other team members
  - Use PRA framework to assist in technical direction of specialized analyses
- Use existing PRA model to identify potential analysis boundaries

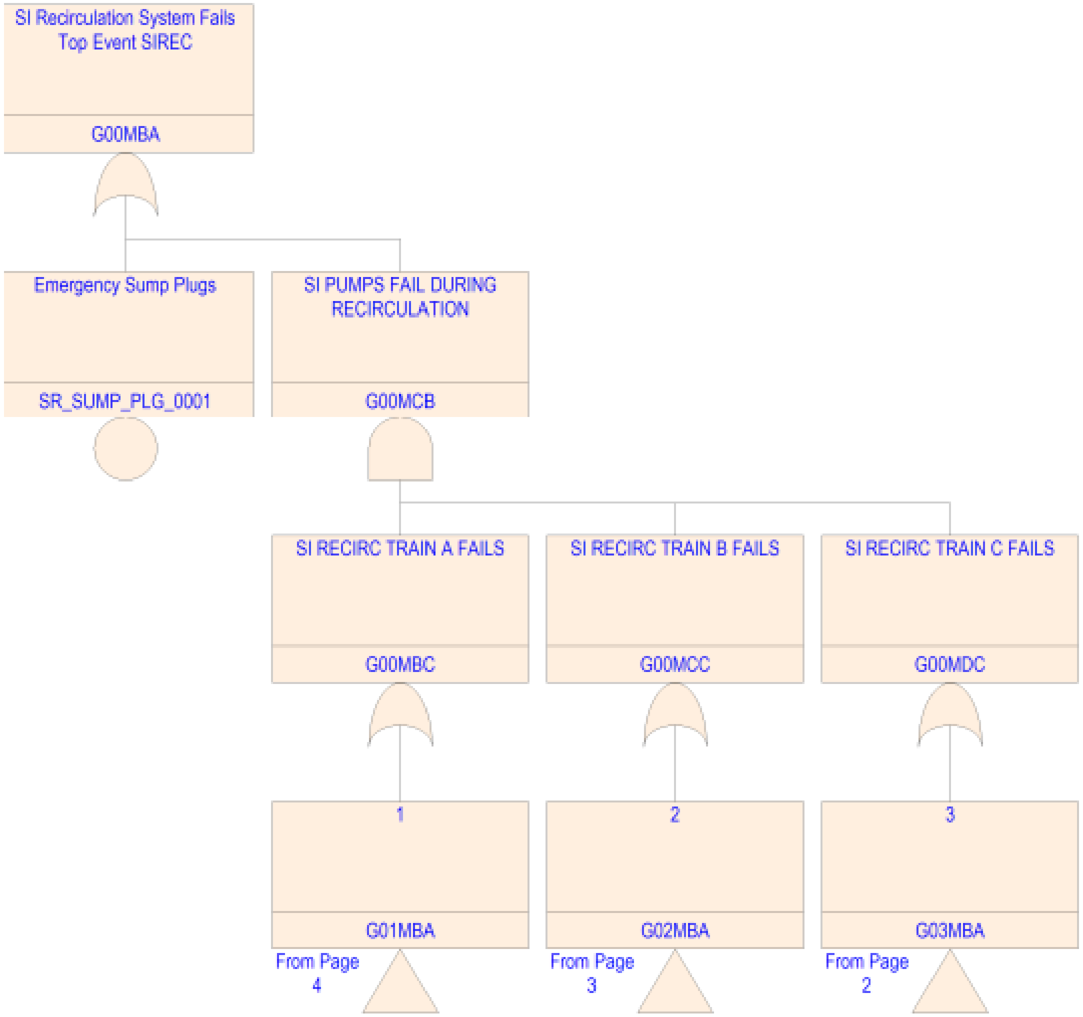
LLOCA Event Sequence Diagram



LLOCA Event Tree



SI Recirculation Fault Tree (Top)



Current and Future PRA Models

- Existing PRA
  - Does not explicitly address sump plugging phenomena
  - Does include a basic event (1E-5) to represent unavailability of sump; required for all sequences involving recirculation
  - At-power importance:
    - FV 4.1E-03; RAW: 4.1E+02 [CDF]
    - FV 2.4E-07; RAW: 1.0E+00 [LERF]
  - Does not address in-core phenomena of material passing strainer
- Current Effort
  - New model will depict detailed representation of phenomena
    - Aid in investigation
    - Assist in documentation of effort
  - Eventual incorporation into PRA model of record
    - Model may be higher level, as appropriate
    - Could result in revised initiator groupings

Example Source Material

- NUREG/CR-6771 GSI-191: The Impact of Debris Introduced Loss of ECCS Recirculation on PWR Core Damage Frequency; LANL (2002)
- ECCS Recirculation Performance Following Postulated LOCA Event: GSI-191 Expected Behavior; NEI (2009)

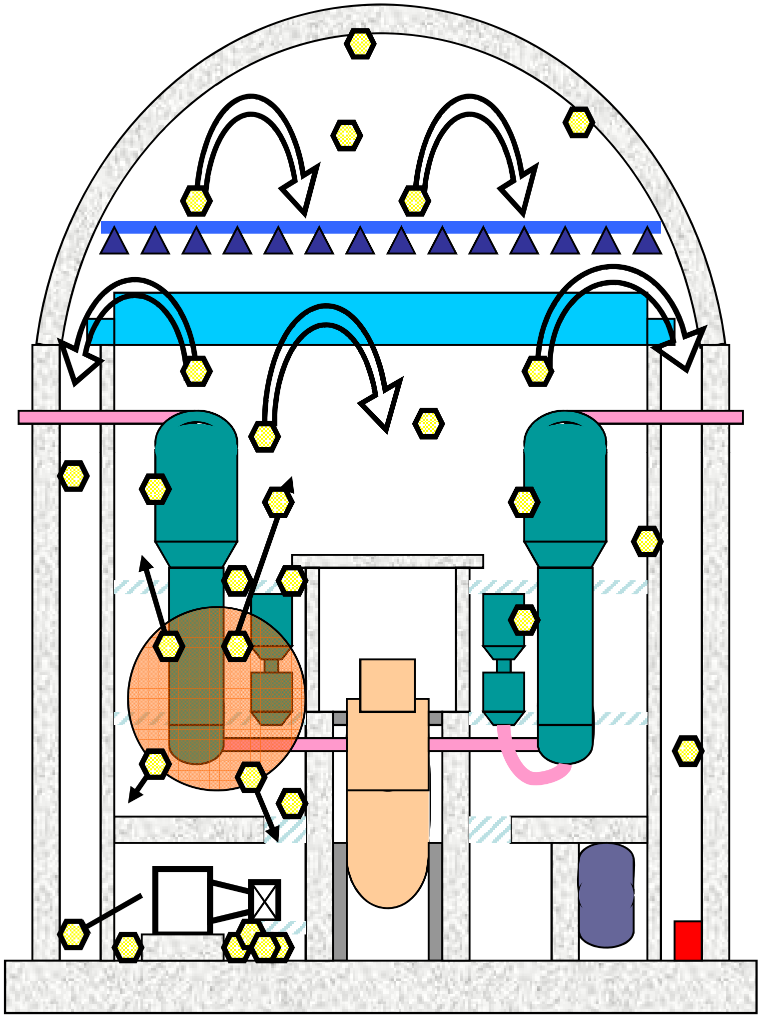
Considerations Include:

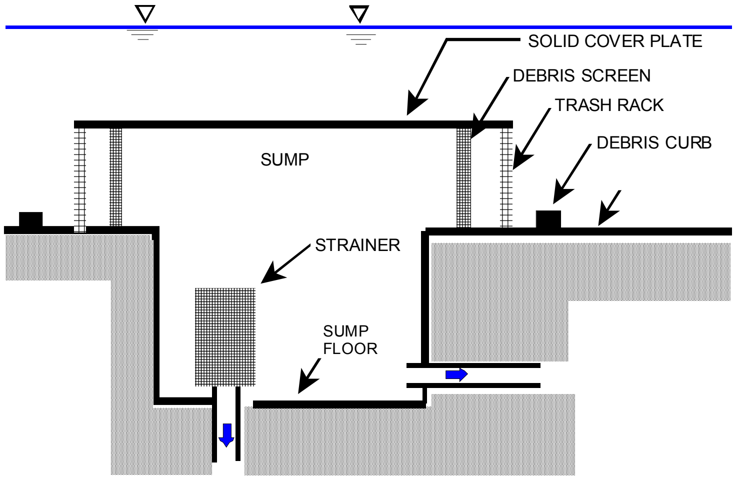
- Break characteristics
  - Location, size, failure mode, opening time, scenario timing
- Zone of influence
- Debris Characterization
  - Debris from insulation
  - Other debris
- Debris Transport and chemistry
- Accumulation at strainer/head loss
- Downstream Effects

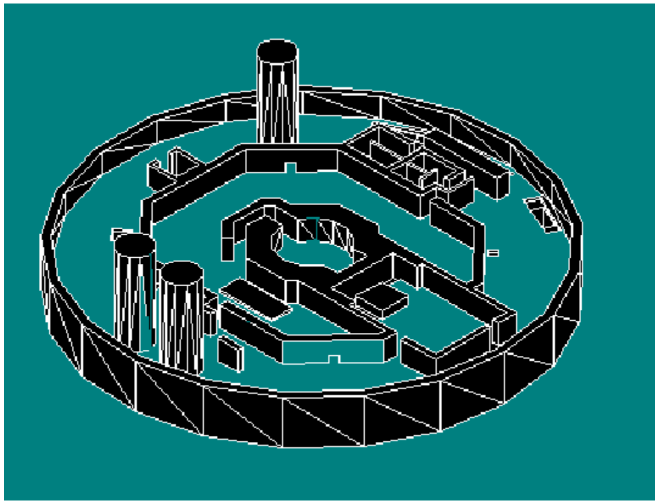
Debris Transport & Sump Blockage (DTSB), Jet Formation Physics, and Uncertainty Quantification (UQ)

Elmira Popova, Erich Schneider: University of Texas at Austin
Bruce Letellier: Los Alamos National Laboratory

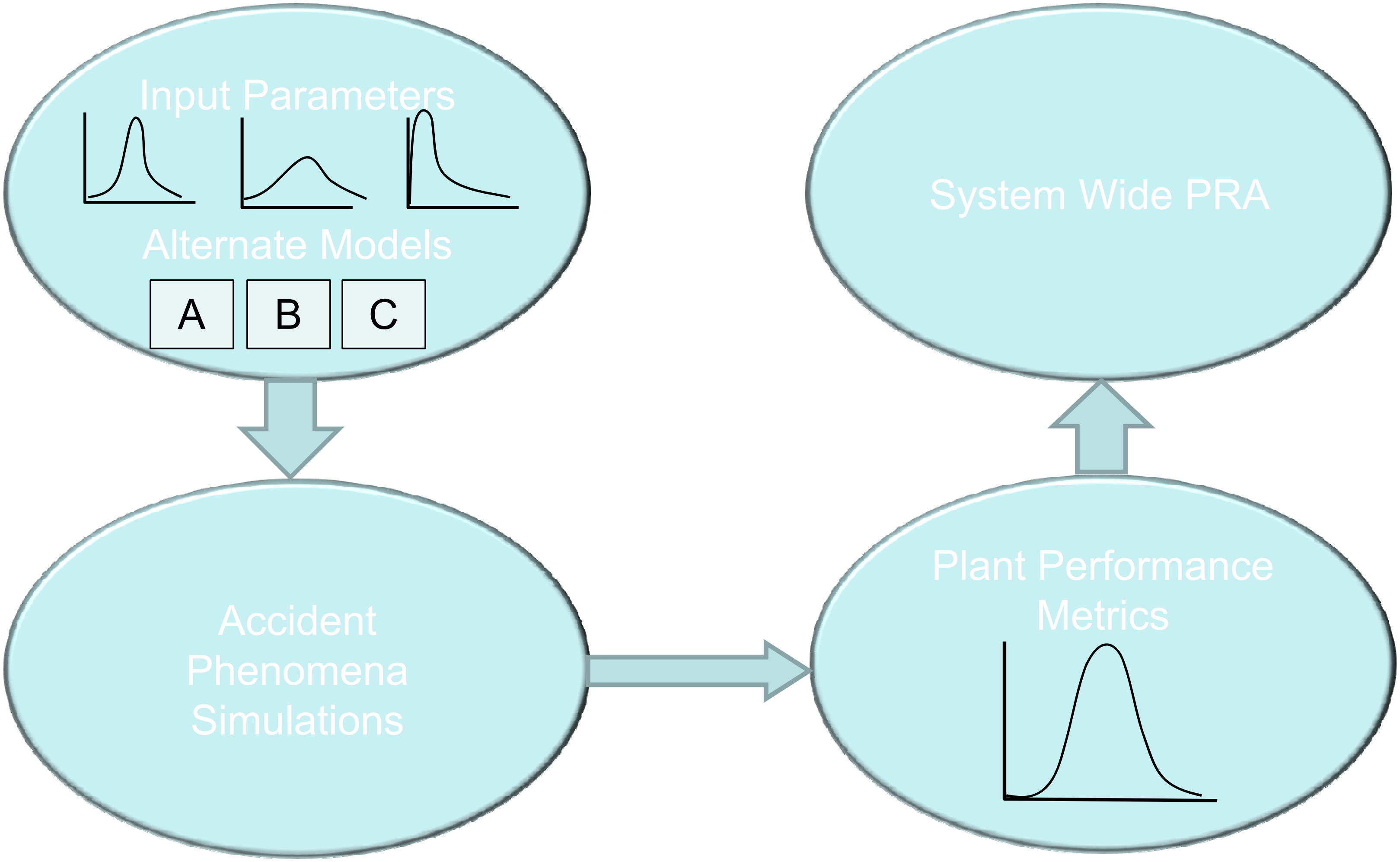
Accident Progression Overview







Conceptual Accident Propagation



Input Parameters

Alternate Models

A B C

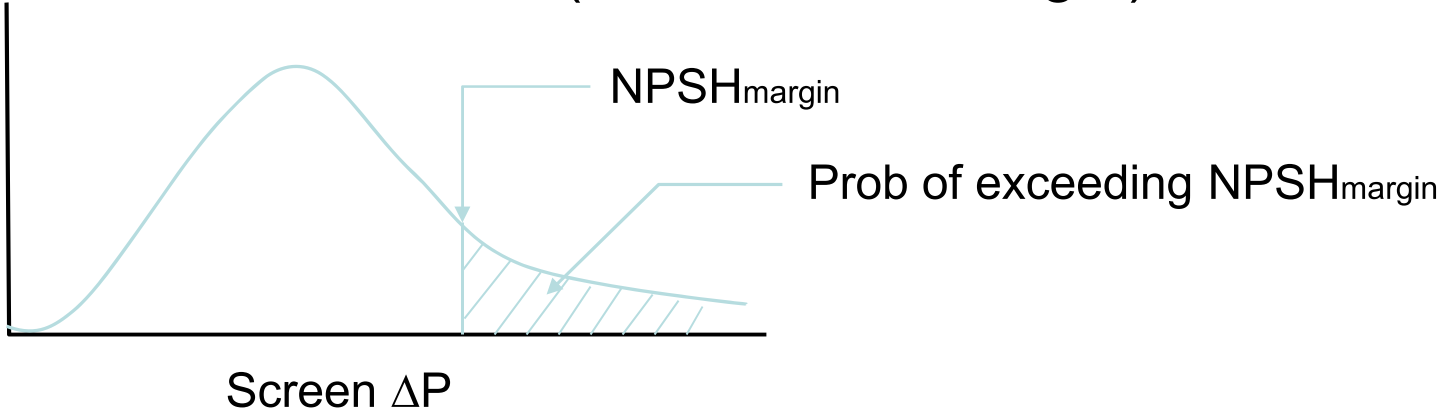
Accident Phenomena Simulations

Plant Performance Metrics

System Wide PRA

Interface to PRA

- Present PRA has only one top event directly related to GSI-191 (Recirculation Cooling)
- Traditionally assume recirculation failure leads directly to core damage
- Use physics models to define distributions and/or required split fractions (analogous to fault trees)
- Key Performance Metric (fixed NPSH margin):



Refined PRA

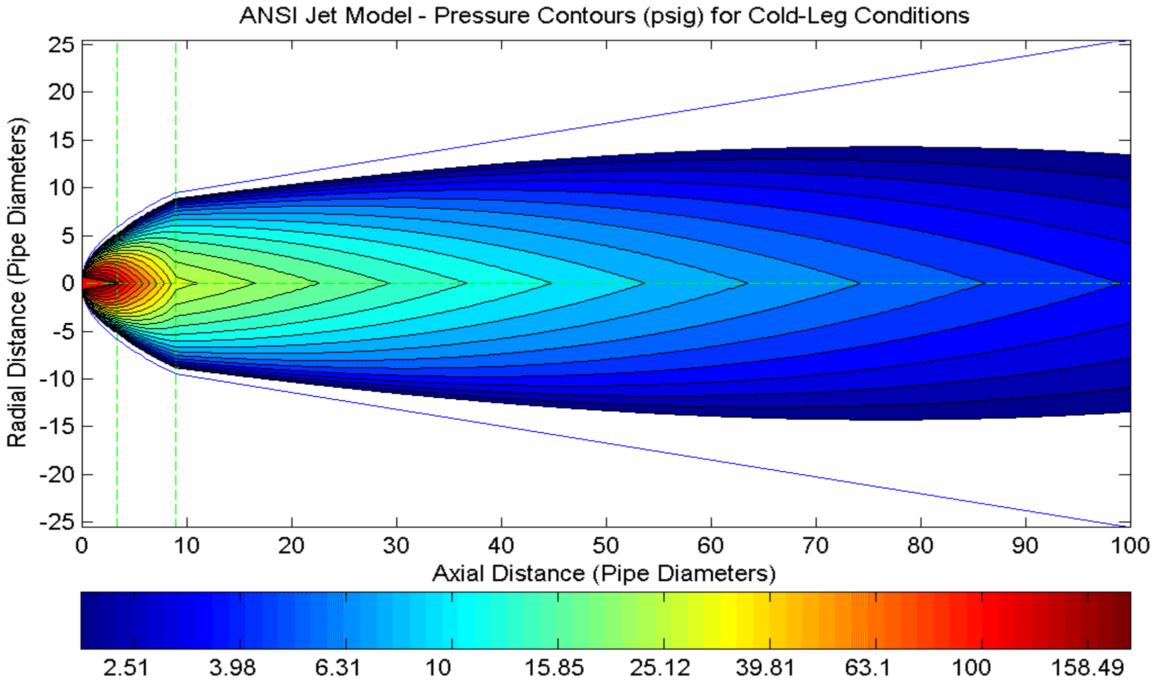
- Downstream effects now raise additional Core Damage states
  - Channel-specific loss of cooling
  - Core average temp
  - Core pressure drop
- Must add top event for reactor flow effects
  - Need operational definition of Core Damage
    - Licensing basis
    - Alternate source term

Technical Strategies

1. Break frequency refinement
2. ZOI estimation
   - Implement spherical approx while improving jet model
3. Sump screen performance
   - Conservatively ignore overpressure credit
4. Degraded pump performance
   - Assume licensing basis failure
5. Reactor flow metrics
   - Parameterize core-wide and fuel assembly blockage
6. PRA refinement for rotating trains
7. PRA refinement for core damage states

Jet Formation Physics: Spherical Approximation

- Conservation of volume enclosed by stagnation pressure isobars (e.g. via ANSI standard ANS88) leads to spherical ZOI approximation
  - ANSI standard addresses freely-expanding jets
  - exhibits (conservative) inconsistencies for small or off-center targets, discontinuities in pressure gradient



Jet Formation Physics: CFD-Guided Parameterization

- CFD can depict velocity field, two-phase jet characteristics that are beyond scope of ANSI model
  - conventional CFD codes cannot simulate important shock and multiphase phenomena
  - **CTH** (SNL) treats the strong-shock, high-pressure, liquid-vapor regime

- Will allow time-dependent break effects and jet impingement / deflection to be investigated

- Use response surface methodology to obtain **ZOI reduced order model (ROM)**
  - quantify boundaries of reliability of the ANSI model
  - correlate a minimal set of explanatory variables to the response (pressure contours)

ZOI Reduced Order Model (ROM): Summary

- Seek Improvements to ANSI Standard – Simplistic and free expansion only.
- Two-phase CFD computationally expensive
- Limited test data (STP + Westinghouse)
- TH state points will vary by break location
- Rupture time and extent will control jet development
- Debris generation controls sequence outcome
- Reflected jet cases will be run to confirm conservatism of equal pressure-volume mapping
- ROM for free jet will facilitate hundreds of break evaluations

UQ – main research directions

- Modeling and propagation of uncertainty in the physics-based models
- Collection and analysis of existing experimental data
- Elicitation and analysis of experts' opinion for cases when there are no real data or published results
- Locating areas where further experimentation and/or analysis is needed

UQ in physics models

- Initially the models will be conservatively approximated and refined as needed to address dominant uncertainties. The framework to address the UQ in physics models will consists of four parts:
  - Uncertainty analysis: quantification of the overall uncertainty in model outputs.
  - Sensitivity analysis and value of information: how the model outputs respond to inputs. How much each uncertain factor impacts the decision-making.
  - Calibration and data assimilation: the process of adjusting the uncertain model parameters to match the model to observed data.
  - Validation

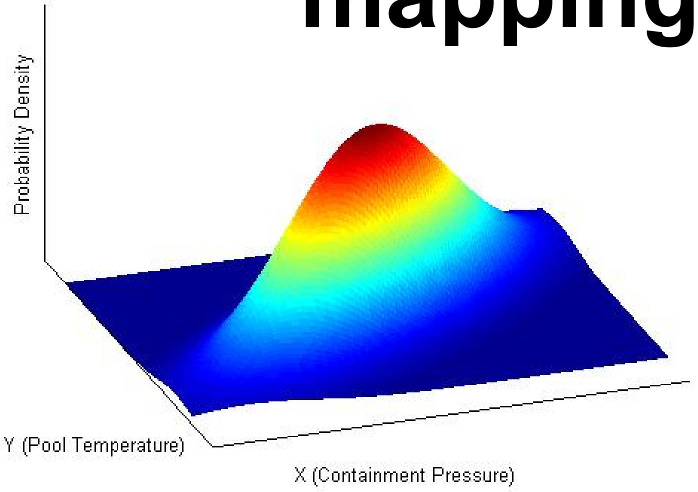
Uncertainty Propagation Tools

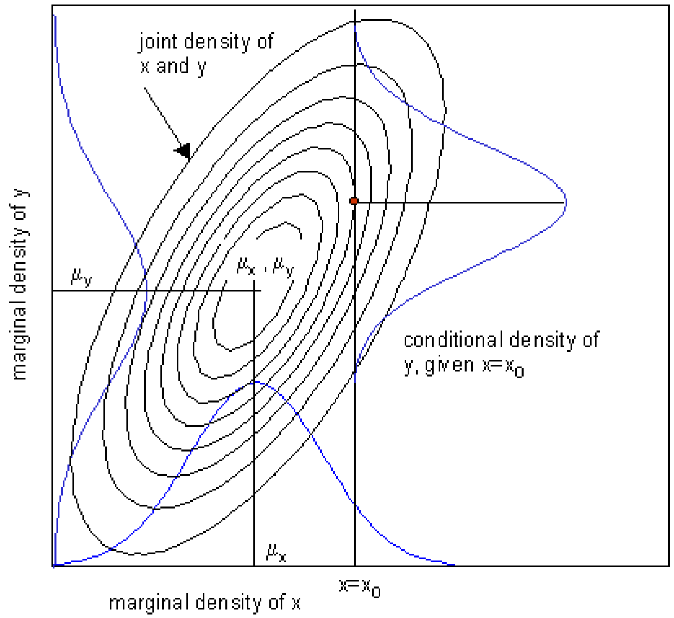
- Dakota and Psuade noninvasive sampling tools
- Objective directed Latin Hypercube Sampling
- Create our own sampling and analysis tools if necessary

Multivariate uncertainties and their mapping to PRA models

- This problem might have many multivariate uncertainties possibly important to uncertainty quantification
  - Uncertainty in containment pressure is dependent on the uncertainty in break flow rate.
  - Uncertainty in sump differential pressure is dependent on the uncertainty in fluid temperature (in turn, is dependent on containment temperature - break flow).
  - Uncertainty in fuel pin failures is dependent on uncertainty in ECCS flow and uncertainty in sump screen particulate penetration.

Multivariate uncertainties and their mapping to PRA models





- Standard inputs for PRA analysis are discrete conditional probabilities
- They are computed from conditional distributions (densities)
- Conditional densities are computed from the joint distribution function (density)

- Example shows two uncertain variables with a positive correlation

- We propose conditional probability of $\text{NPSH}_{\text{margin}}$ loss as one important interface to the PRA

Performance Measures

- Computable as point values:
  - Continuous, ex. screen head loss, max pin temp
  - Categorical, ex. low, med, hi debris penetration
  - Binomial, ex. spray trip (yes/no)
- Can view as joint prob. of plant response
  - Marginalize to isolate any subset of 1 or more
  - Diagnose sensitivity to plant variables
  - Exploit correlations

Performance Measures

- CDF and LERF are top-level desired metrics, but intermediate measures are regulated and may serve as "pinch points" for aggregation and resampling to propagate variability

1. Loss of $\mathrm{NPSH}_{\mathrm{Req}}$
2. Loss of adequate flow
3. Pump Cavitation
4. ΔP_{core} because of internal debris
5. Peak pin temp
6. Failed cladding
7. Valve failure from erosion
8. PRA failures
   - Pump start
   - Recirculation alignment
   - Spray actuation
9. Air ingestion
   - Vortexting
   - Deareation

- Can imagine a joint probability distribution function for all of these

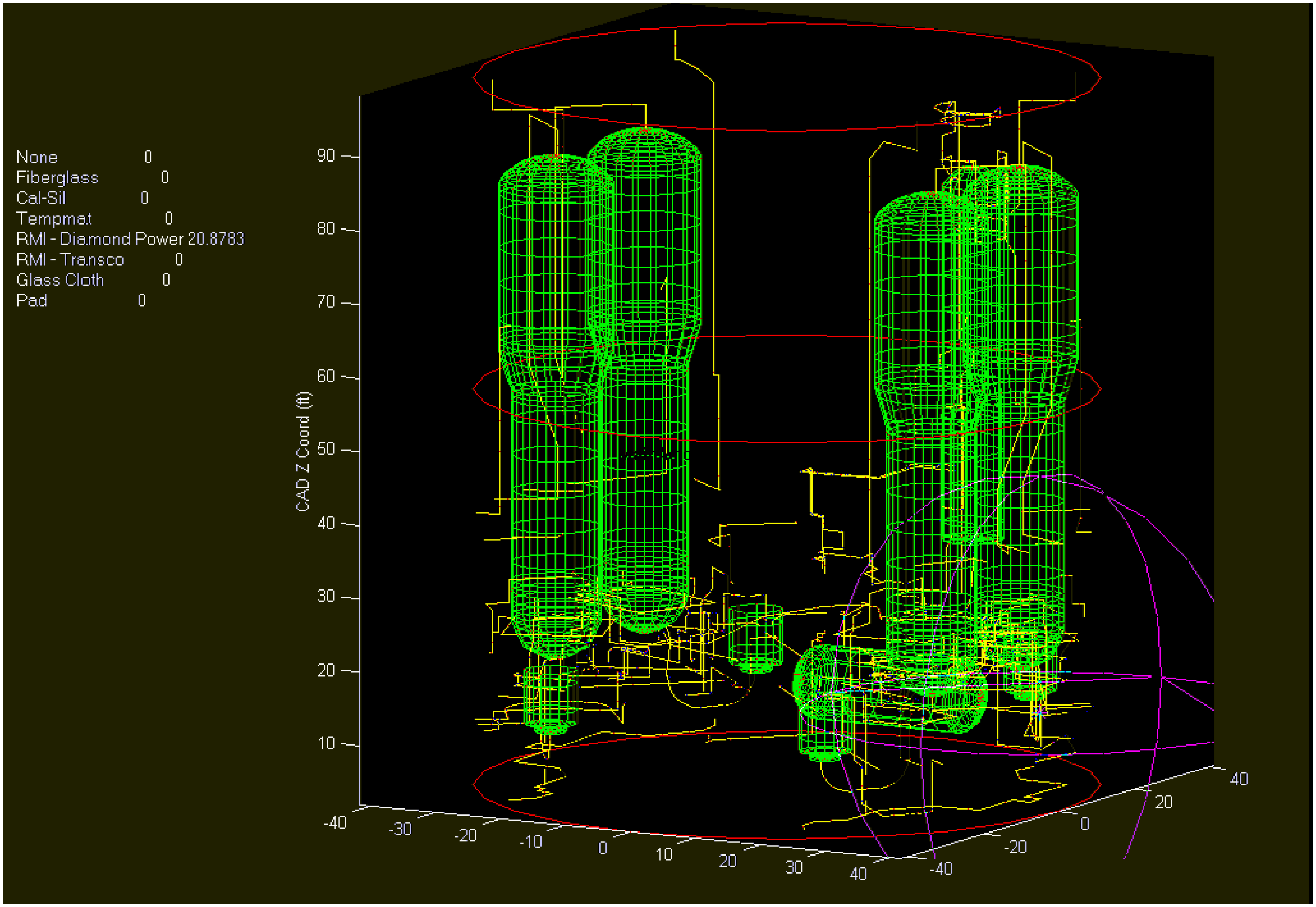
Stochastic Wrapper – CASA Grande Containment Accident Stochastic Analysis

- Develop a “stochastic wrapper” that would integrate the different models developed in the core damage frequency analysis in such a way that the appropriate distributions are made available to the event tree logic structure.
- Containment Accident Stochastic Analysis (CASA) Grande will function as a supplementary event tree to track debris fate
- CASA Grande will combine all uncertainties:
  - From the uncertainty propagation in the physics models
  - From statistical analysis of available experimental data
  - From analysis of information elicited from experts
  - We will use Bayesian methods and analysis to perform the above tasks
- Bayes Context:
  - Prior space of uncertain parameters is mapped by physical Likelihood into Posterior plant performance measures

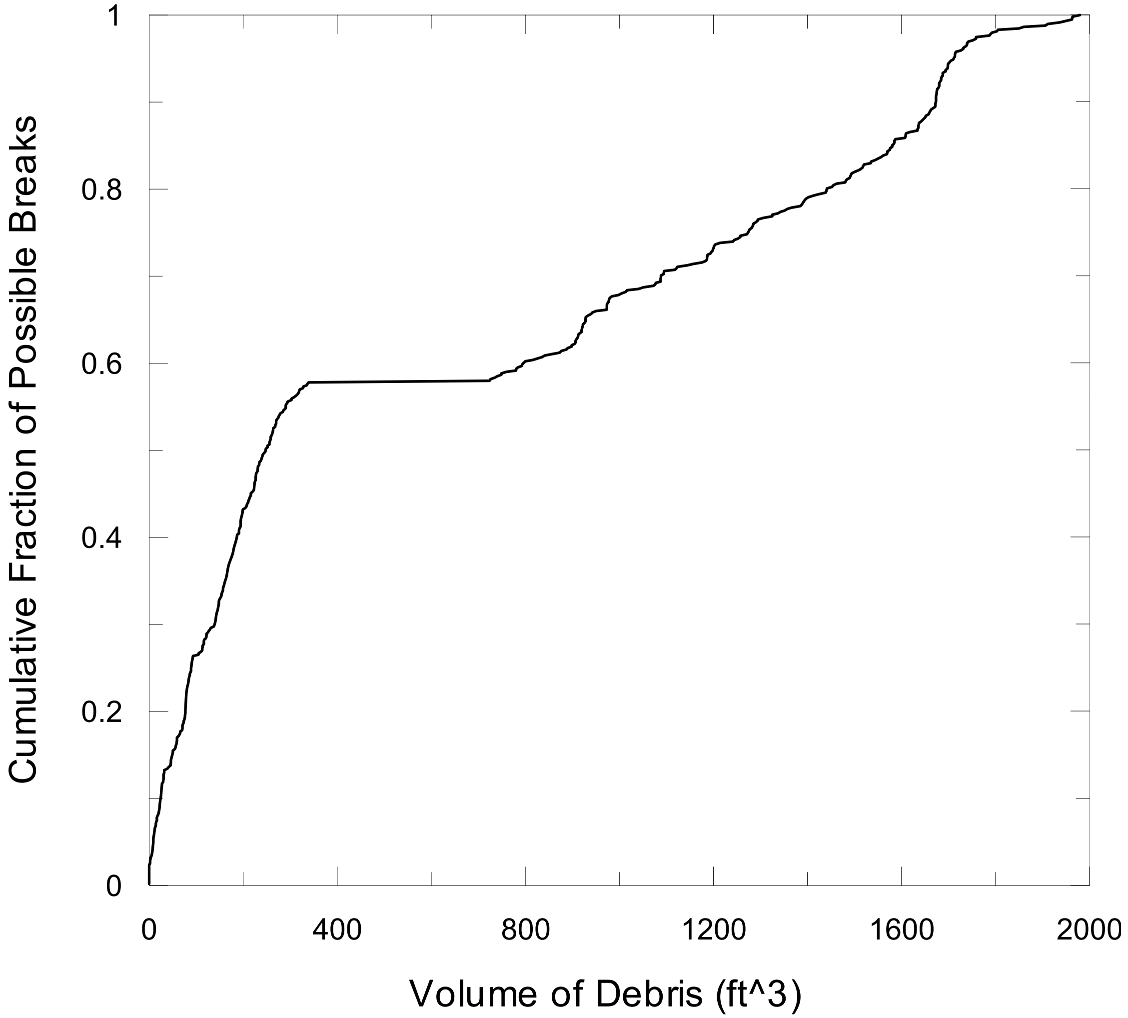
CASA Grande

- Grounded in plant CAD visualization
  - CAD defines spatial coordinates of:
    - Energized piping runs – potential break locations
      - Plant system, diameter, temp, pressure
    - Insulation – debris formation targets
      - Product, thickness, jacketing, banding
    - Coatings – thickness, quality
    - Concrete barriers – jet redirection
    - Gratings – debris retention
    - Pool geometry
    - Sump screen location, configuration

CASA Grande Prototype



Prototypical Debris Distribution from Spherical ZOI



Thermohydraulic (T/H) and Downstream Effects Analyses Overview

Dr. Y. Hassan
Texas A&M University

Thermal-Hydraulic Analysis – Project Requirements

- Analysis of the System Response during Loss of Coolant Accident (LOCA)
    1) Different Break Locations
    2) Different Break Sizes
    3) ECCS and Plant system response
- Sensitivity Analysis (SA):
    - Range of Conditions at which Recirculation is required
    - Time to Recirculation
    - Time to Containment Spray Initiation

- Uncertainty Quantification (UQ)

- Providing Boundary Conditions for the Jet Model Development

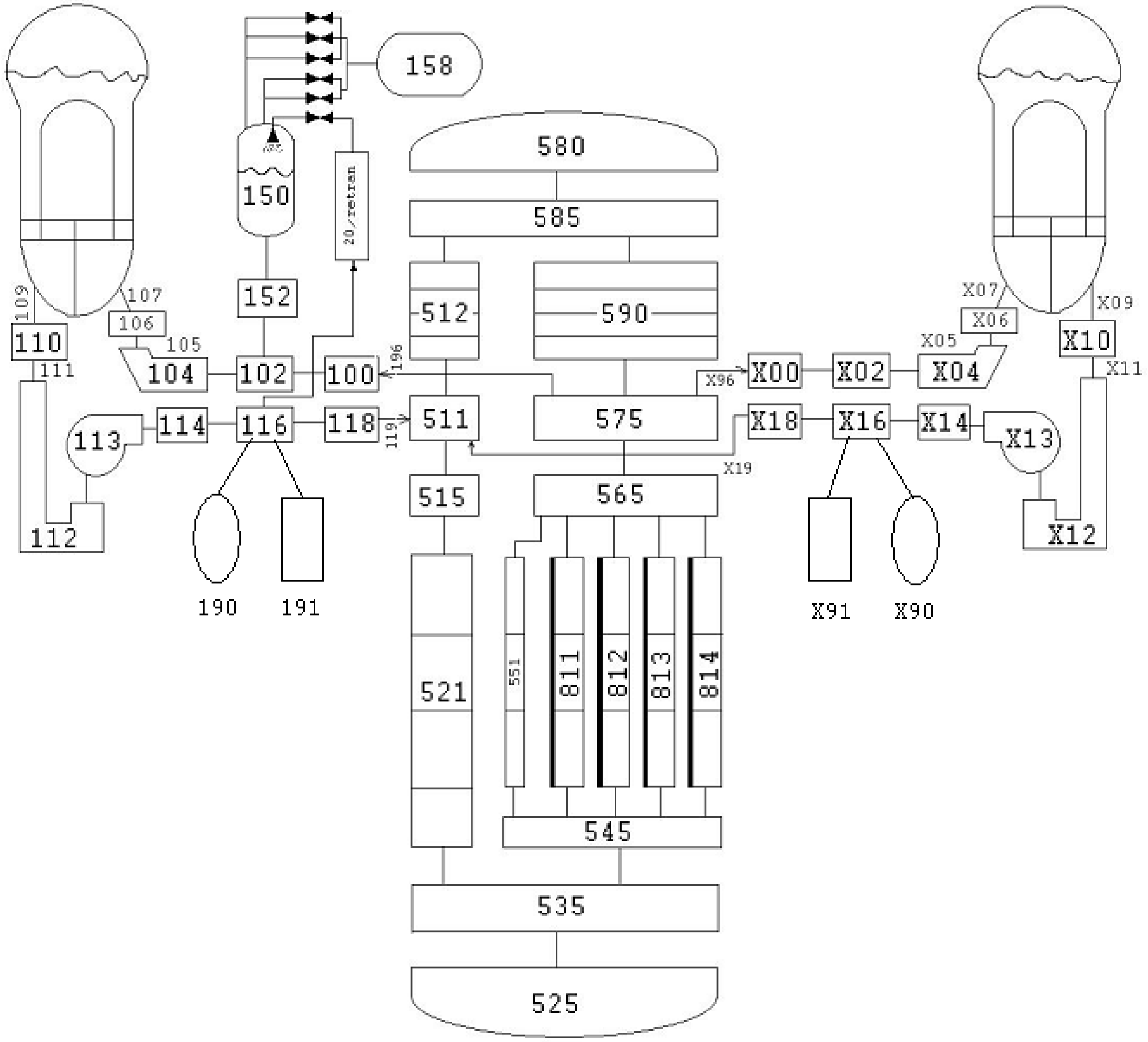
Thermal-Hydraulic Analysis – Tools

- **RELAP5-3D** will be mainly used to perform the Thermo-Hydraulic Calculations
    - ✓ Basic STP Plant Nodalization Already Available
    - ✓ Steady-State Analysis already Started
- **RELAP5-3D** will be Coupled with **DAKOTA** in order to perform Sensitivity Analysis (SA) and Uncertainty Quantification (UQ)

Thermal-Hydraulic Analysis – Tools

- **DAKOTA** is a tool that will allow batch processing of a large number of RELAP5-3D calculations
  - This is accomplished via modifying RELAP5-3D input files to change parameters of calculation (e.g. break size, break location)
  - As a result we obtain the range of conditions that require recirculation.
- **DAKOTA** is a tool with wide usage at the DOE-NNSA labs and the wider community.
  - It has a strong foundation of verification and validation.

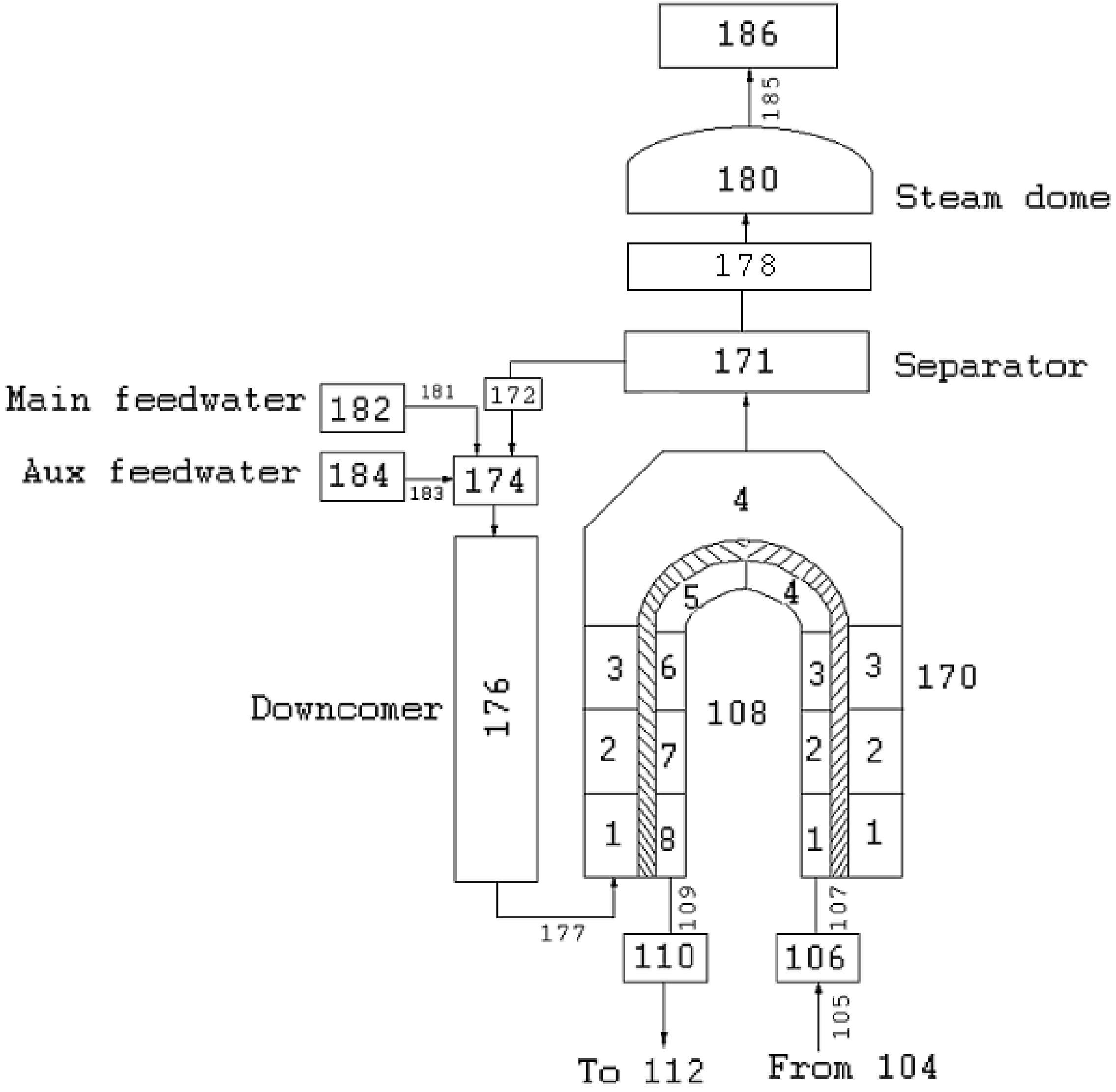
RELAP5-3D Primary System Nodalization (Steady-State)



4 Independent Loops:
12 Components
27 Nodes
1 Heat Structure
Reactor Vessel:
17 Components
32 Nodes
4 Heat Structures
of which in *Active Core*:
4 Pipes
4 Heat Structures
Point Reactor Kinetic
Pressurizer:
2 Components
4 Nodes

Tot. Components:	67
Tot. Nodes:	144
Tot. Heat Structures:	8

RELAP5-3D Secondary System Nodalization

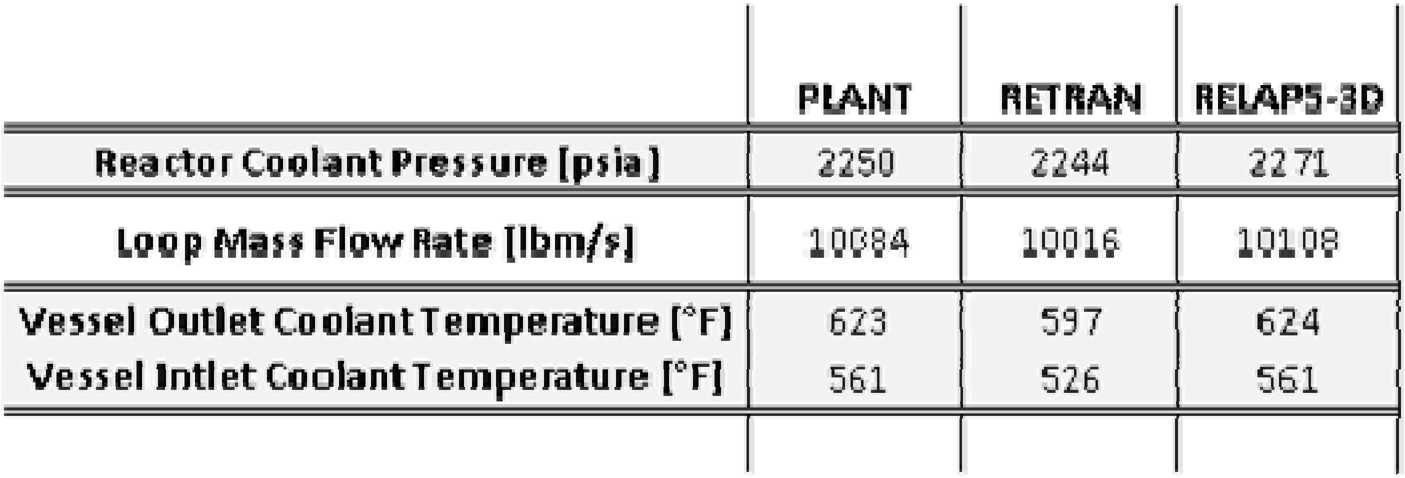


Secondary Section (x4):
10 Components
13 Nodes

Full Plant Nodalization Summary:

Tot. Components:	109
Tot. Nodes:	196
Tot. Junctions:	49
Tot. Heat Structures:	8

RELAP5-3D / RETRAN Steady-State Comparison



	PLANT	RETRAN	RELAP5-3D
Reactor Coolant Pressure [psia]	2250	2244	2271
Loop Mass Flow Rate [lbm/s]	10084	10016	10108
Vessel Outlet Coolant Temperature [°F]	623	597	624
Vessel Intlet Coolant Temperature [°F]	561	526	561

Downstream Effects Analysis – Project Requirements

- Analysis of the Effects induced by Debris Deposition and Accumulation in the Primary System

- Identify Success Criteria (i.e. Failed Fuel Pins)

- Other issues (for example ECCS component reliability will be considered)

Downstream Effects Analysis – Tools

- Computational Fluid Dynamics (**CFD**)

- Overall System Response Analysis will be performed using **RELAP5-3D**

- **DAKOTA** can be used in both the CFD and system response portions of this analysis

Communication & Milestone Plan

Milestone Plan

- **2010 October - November**
  - *Meet with Regulator to propose risk-based licensing strategy**
  - *Obtain plant stakeholder buy-in to risk approach*
  - *Presented plan to PRT*
- **2010 December 2010**
  - *Project Plan developed, contract negotiation for 2011 work.*
  - *Contract negotiations for work in 2011 commenced*
  - *Project Team meeting to develop work breakdown and best-guess schedule.*
  - *NRC Commission issues SRM recommending risk informed approach to complete resolution of GSI-191*
- **2011 January – February**
  - Final Contract negotiations completed
  - *Project Team meeting to finalize inter-model communication (TH, DTSB, DEM)*
  - ***NRC Public Meeting January 27th at NRC HQ***
  - Formal Kick-Off Meeting with NRC to communicate risk-based approach plan
  - Licensing strategy finalized (Regulator concurrence).
  - Data & Information from STP to Project Team (FSAR data, latent debris loading, water balance, etc.)
  - TH model development (jet boundary condition, downstream effects models)

*Italics indicates actual completion

Milestone Plan (continued)

- **2011 March – April**
  - Review Report of available literature - pipe fracture mechanics (**Deliverable)**
  - Best estimate of pipe failure distribution (opening rate, size, geometry)
  - Provide break characterization to TH group.
- **2011 May - June**
  - CAD Model description of containment/piping with insulation burden
  - Pipe failure distribution (locations, rates, likelihoods) input development for DTSB model.
  - Containment response finalized (primarily sump fluid temperature).

Milestone Plan (continued)

- **2011 May - August**
  - Minimum break size requiring recirculation phase
  - TH response spectrum complete **(Deliverable)**
  - Complete uncertainty distributions for all supporting analyses
  - Complete all preliminary TH/DEM calculations
  - Revise LOCA break frequencies based on the above
- **2011 September – November**
  - PRA Model incorporation complete.
  - **INITIAL QUANTIFICATION (DELIVERABLE)**.
  - Evaluate results & recommend path forward (risk informed or not)
- **2011 December**
  - Incorporate feedback from internal reviews.
  - Executive report for Regulator/Industry review.

2012 - 2013 Plan

- Will be based on 2011 initial quantification results and interactions with NRC
- Emphasis and scope will be on areas where highest uncertainties remain
- May require additional testing and/or experiments

Requirements for a Robust Risk Analysis

- Realistic models are needed to properly characterize uncertainty in our state of knowledge and variability in phenomenology.
- Additional effort is required to identify and subsequently reduce uncertainty (if possible) in otherwise acceptable (mean value) failure scenarios with large “tails”.
- An enormous number of scenarios (as opposed to a single deterministic methodology) are required to be analyzed and understood for a complete risk analysis.
- Additional information (important measurements, ranges, types) may be required to focus on phenomenology contributing most to uncertainty and/or levels of risk.

SUMMARY

- A risk informed approach for closing GSI-191 has been developed which will employ robust probabilistic methods
- A highly qualified and specialized team has been assembled to undertake this project
- A project plan has been developed with milestones for regulatory/industry communication and project completion
- The intent of the project will be to develop a risk informed GSI-191 closure process that can be replicated by others

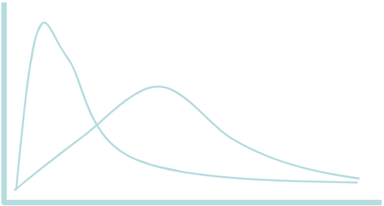
ACTIONS

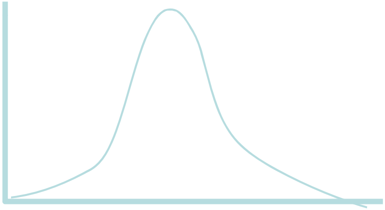
Action	Responsibility	Date Needed

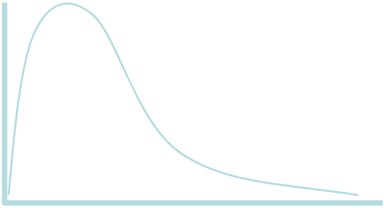
TECHNICAL BACKUP SLIDES

Closure Strategy

- Place GSI-191 related risk contributors in context of plant-wide PRA. *Then,* interpret ΔCDF and ΔLERF using RG 1.174
- Describe accident sequence phenomena in probabilistic terms based on present state of knowledge and variability in available data


ZOI


Wash Fraction


Debris Size

- Propagate uncertainty to distributions of plant performance that link naturally to a refined PRA
  - LOCA frequency to credit fracture mechanics and inspection procedures
  - Introduce operator option to rotate between trains

Team Assignments

- Texas A&M
  - RCS full-power simulation and transient system response (boundary conditions for break simulation)
  - Fuel temp parameterizations
- University of Texas
  - Uncertainty Quantification (break frequency, etc)
  - Sampling and propagation strategies (CASA Grande)
  - Break Zone Simulation (CTH)
  - Pool velocity simulation (if needed)

Team Assignments

- Los Alamos National Laboratory
  - Containment response (if needed)
  - Sump screen performance
  - Develop CASA Grande analysis tool
- ABS
  - PRA modification and evaluation
  - Consultation regarding Risk-Informed implications
- Massachusetts Institute of Technology
  - Internal review of PRA and accident seq interface

Team Assignments

- Alion
  - As-built CAD
  - Compilation of test data report
  - Consultation on debris transport and sump performance
- STP
  - Plant data interface
  - Licensing strategy
  - Project management
  - Plant operations configuration and flexibility

Biographical Backgrounds

- Project Management
- Technical Team

C. R. (Rick) Grantom

Mr. C.R. (Rick) Grantom is the Manager of Risk Management Projects at the South Texas Project Electric Generating Station in Wadsworth, Texas. Mr. Grantom has been responsible for the development, application, implementation, and overall management of STP's Risk Management programs, the STP PRA, and the station's risk and reliability analysis programs. He is currently focused on developing a risk informed approach supporting GSI-191 closure as well as other strategic risk initiatives. He has over 30 years of nuclear power plant experience, 27 of which are directly related to risk management methods and their application to nuclear power plants.

In the past Mr. Grantom has had direct involvement in the development, approval, and implementation of several key risk informed initiatives at the South Texas Project. These risk informed application areas include: Plant Configuration Risk Management; Exemption from Special Treatment Requirements (Prototype Pilot); Risk Managed Technical Specifications, 4B (Industry Pilot); Owner Controlled Surveillance Frequency Program, 5B.

In addition to his duties at the South Texas Project, he is the Co-Chairman of the ASME/ANS Joint Committee on Nuclear Risk Management, an ex-officio member of the ASME Board on Nuclear Codes and Standard, the Vice-Chair of the EPRI Risk and Safety Management Technical Advisory Committee, and the STARS Risk Management Team Leader.

Mr. Grantom holds a B.S. Degree in Nuclear Engineering from Texas A&M University and is a registered Professional Nuclear Engineer in the State of Texas.

Technical Team
Principal Investigator Backgrounds

Dr Elmira Popova

Dr. Elmira Popova is Robert and Jane Mitchell Endowed Professor in Mechanical Engineering at University of Texas at Austin. She graduated with MS in Mathematics from University of Sofia, Bulgaria in 1985, and PhD in Operations Research from Case Western Reserve University, Cleveland, OH in 1995. In 2008 she was named a Fulbright Scholar and in 1999 she was given the Halliburton/Brown & Root young faculty excellence award in teaching and research. Dr. Popova specializes in stochastic processes, computational Bayesian statistics, and stochastic optimization. She is interested in reliability analysis and design of optimal maintenance strategies for randomly failing systems.

Since 2004 she has collaborated with the Risk Management group at South Texas Project Nuclear Operating Company on designing and developing a new risk-informed system for reliability estimation and preventive maintenance scheduling. The main objective of the Risk Informed Asset Management program is: to make optimal risk-informed decisions at both operational and executive management levels by taking into account budget, internal project dependencies, outage duration, and regulatory safety constraints; to appropriately model and include the uncertainty related to rates of return on investments, energy prices, failure mechanisms, and costs for replacement and spare parts; and to provide decision-makers quantified feedback on decision- making performance. A preliminary version of the system is currently being tested by their systems engineers. Dr. Popova’s research has been funded by NSF, DNDO, NRC, DOE, STPNOC, EPRI, and several other industrial sponsors.

Dr. Bruce Letellier

Dr Letellier has been employed at Los Alamos National Laboratory for 21 years as a member of the Probabilistic Risk Analysis (PRA) Group where he has performed accident-phenomenology and health-consequence modeling for weapon-system and facility safety studies including both commercial and research nuclear reactors. He recently served as team leader of a multidisciplinary effort to support the U.S. NRC in the research and regulatory resolution of generic safety issue (GSI) 191 that involves loss of recirculation sumps during a LOCA. GSI research included (1) integrated chemical effects testing involving a series of 30-day, closed-loop, simulations of reactor accident environments, (2) measurement and theoretical prediction of pressure loss in prototypical debris beds, (3) computational fluid dynamics (CFD) simulations of complex flow geometries in pressurized-water-reactor containment buildings, and (4) reactor system risk assessments to quantify the impacts of operator recovery actions in response to loss of a primary recirculation system. Modeling and simulation experience relevant to this project include containment transient accident analysis using MELCOR, thermal hydraulic jet expansion using CTH, and CFD studies using both FLUENT and FLOW-3D. Present work includes uncertainty quantification and PRA for complex engineered systems associated with capture and sequestration of carbon dioxide. Letellier holds B.S., M.S. and PhD degrees in nuclear engineering from Kansas State University where he completed his dissertation on Bayesian inversion of gamma-ray spectra to determine contamination profiles in soil.

Dr. Erich Schneider

Dr Schneider received his PhD from Cornell University in 2002 and joined the UT-Austin faculty in 2006. He has been involved in nuclear fuel cycle systems analysis under Fuel Cycle Research and Development and its predecessors since he joined the staff at Los Alamos in 2002. While at LANL, he contributed to zone of influence (ZOI) model development and characterization for NRC Generic Safety Issue 191, “Assessment of Debris Accumulation on PWR Sump Performance.” He has been a RELAP5 user for over 15 years, beginning with RSCS model implementation and loss of offsite power scenario analyses for the proposed Advanced Neutron Source Reactor at ORNL. He co-developed a methodology for characterizing coupled neutronic-thermal performance of experiments in the ATR National Scientific User Facility. Most recently, he mentored an IAEA Fellow who implemented a TRACE model of the 1.1 MW TRIGA research reactor at UT-Austin. Dr. Schneider has presented to the ANTT Subcommittee of NERAC, been invited to brief NE-1 Dr. Pete Miller, and testified before the fuel cycle subcommittee of the Blue Ribbon Commission on America’s Nuclear Future.

Dr Yassin Hassan

Yassin Hassan is Professor and Associate Department Head of the Department of Nuclear Engineering and also Professor of the Department of Mechanical Engineering at Texas A&M University. He received his Ph.D. and MS in nuclear engineering from University of Illinois, and MS in mechanical engineering from University of Virginia. Prior to joining Texas A&M September 1986, he worked for seven years at Nuclear Power Division, Babcock & Wilcox Company, Lynchburg, Virginia. His research is in computational and experimental thermal hydraulics, reactor safety, laser-based flow visualization and diagnostic imaging techniques, system modeling, transient and accident analyses, advanced nuclear reactors and aerosol dynamics. He is the editor-in-chief of the premier Nuclear Engineering and Design Journal.

He serves as a technical expert for the International Atomic Energy Agency, national laboratories and a number of other technical review panels. He has served as adjunct professor at several international universities. He is awarded the 2008 American Nuclear Society Seaborg Medal, the 2003 George Westinghouse Gold Medal award, and the 2004 Thermal Hydraulics Technical Achievement award.

David Johnson, Vice President, Quantitative Risk Analysis and Management

David Johnson, ScD, is the Vice President leading the Quantitative Risk Analysis and Management Competency Center. He has more than 30 years experience in providing risk-informed information to decision-makers.

Prior to joining ABS Consulting, Dr. Johnson was Vice President and Chief Scientist of PLG, one of the world's leading risk management firms. He led the development of probabilistic risk models for commercial nuclear power plants as well as for several research reactors. He has contributed to the development of risk management methods. He was also actively involved in the adaptation and use of quantitative risk analysis to DOE and DoD applications.

Prior to PLG, Dr. Johnson was a Fellow of the Advisory Committee on Reactor Safeguards where he contributed to the Committee's evaluation of the use of operational experience in risk management and the development of the ACRS quantitative safety goals. He currently serves on the Board of Directors of the International Association for Probabilistic Safety Assessment and Management.

Dr. Johnson received his bachelor's degree in Nuclear Engineering Sciences from the University of Florida and his masters and doctorate degrees from the Massachusetts Institute of Technology in Nuclear Engineering with a specialty in Applied Radiation Physics.

Ernie Kee

Mr Kee has spent twenty five years in light water reactor operations, research, performance evaluation, and maintenance. His operation experience includes commercial pressurized water reactor and US Navy applications. The research experience includes experiment design and analysis support using reactor safety codes such as TRAC and RELAP5 for transient analyses on commercial and experimental reactors in the US and abroad. Performance evaluation experience includes routine field measurements of reactor operating parameters using installed plant instrumentation, plant chemistry data analysis for fuel performance, and special test support for trouble shooting fuel modifications. Maintenance experience includes trouble shooting, corrective maintenance, and overhaul on US Navy nuclear submarine mechanical systems. Currently supervise four full time engineering (two undergraduate, one Master’s, and one PhD) and one graduate (mathematics) employees in the Risk Management group at STP. The group develops, implements, and trains (STP Operations, Maintenance, and Engineering staff) on the methodologies used at STP to evaluate on-line configuration risk. These methodologies implement quantitative analysis for NRC Initiative 4b, Initiative 5b, NRC Maintenance Rule, INPO Mitigating Systems Performance Indicators (MSPI), and internal risk measures (Risk Index and Work Week Risk). Also regularly supervise University interns (both graduate and undergraduate) during the summer break. Indirectly supervise a post-doctoral employee in cooperation under TEES grants funded by STP.