Alloy 600 Management - Current and Future Plans
xLPR Modular Code

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Topics Discussed

- Problem and Motivation
- Recent Activities
- Uncertainty Propagation
- QA and V&V
- Status and Schedule

xLPR

Problem / Motivation

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- NRC SRP 3.6.3: LBB analyses not approved for lines with active degradation.

NUREG-0800

U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN

3.6.3 LEAK-BEFORE-BREAK EVALUATION PROCEDURES

REVIEW RESPONSIBILITIES

- PWSCC is an active degradation mode
- LBB approved for piping systems prior to PWSCC operational experience
- LBB systems still in compliance with regulations
- NRC RIS on LBB with overlays
- Qualitative: mitigations and inspections
- Quantitative: probabilistic evaluation to assess compliance (xLPR)

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xLPR

What to Do? … Recent Activities

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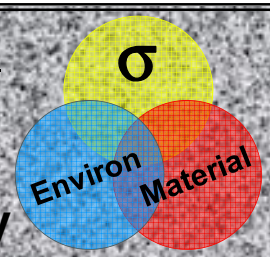
Active Degradation

Qualitative Arguments
- Cracking is limited & shallow
- Cracking is axial

PWSCC Mitigation
- Mechanical stress improvement
- Weld over/on/in-lay
- Water chemistry control



Periodic Inspections
- Monitor crack growth

Adequate Protection of Public Health & Safety

Short Term Approach!

xLPR

What to Do? … Longer Term

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- Develop a ***probabilistic*** assessment tool that can be used to assess compliance with 10CFR50App-A GDC-4
- Tool should be
  - **Comprehensive** with respect to known challenges and loadings
  - **Vetted** with respect to scientific adequacy of models and inputs
  - **Flexible** to permit analysis of a variety of in service situations
  - **Adaptable** – able to accommodate
    - evolving / improving knowledge
    - new damage mechanisms

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xLPR Development

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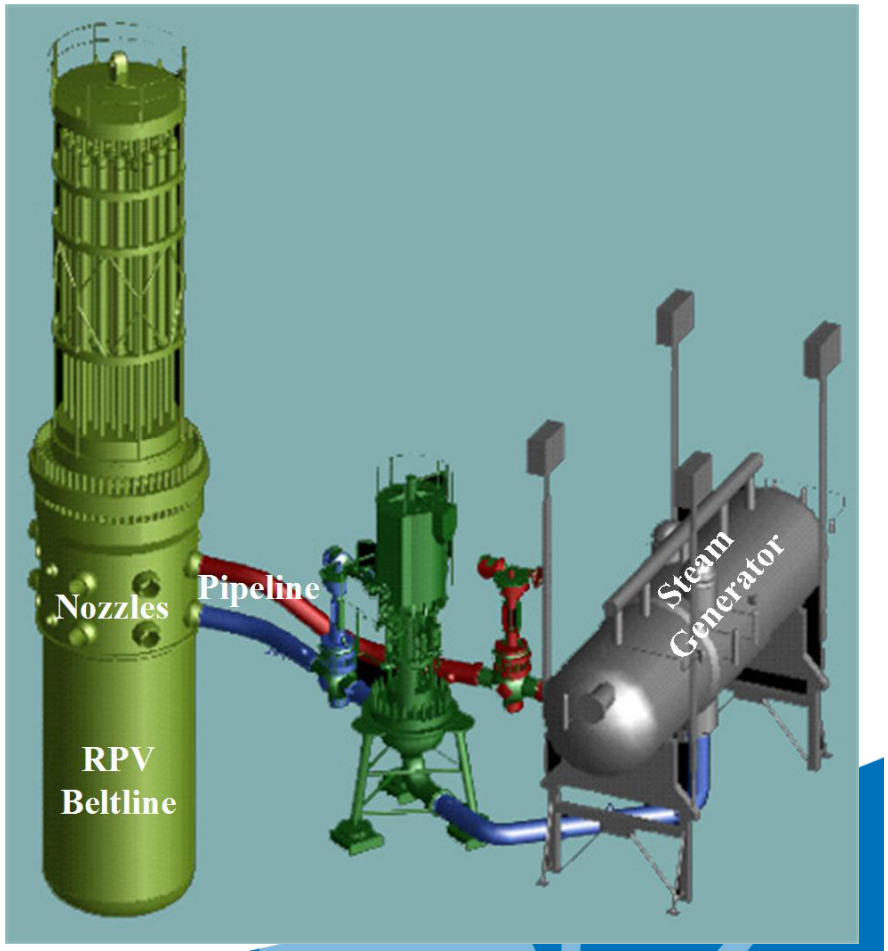
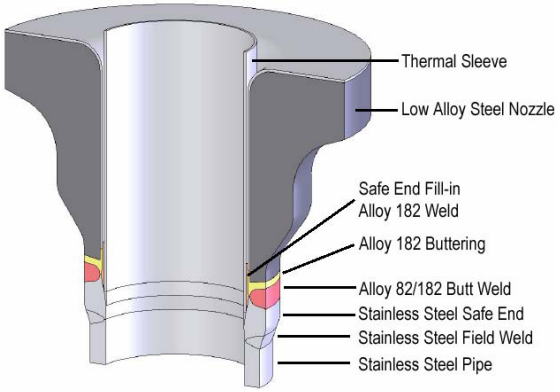
- NRC goal to develop "Modular" code for addressing issues related to Risk of Pressure Boundary Integrity Failure.
- Currently focusing on piping issues (xLPR) to solve current need
- Working cooperatively with EPRI through a Memorandum of Understanding Addendum
- NRC and Industry staff participation in all aspects of code development
- Initial pilot study to assess effectiveness of approach

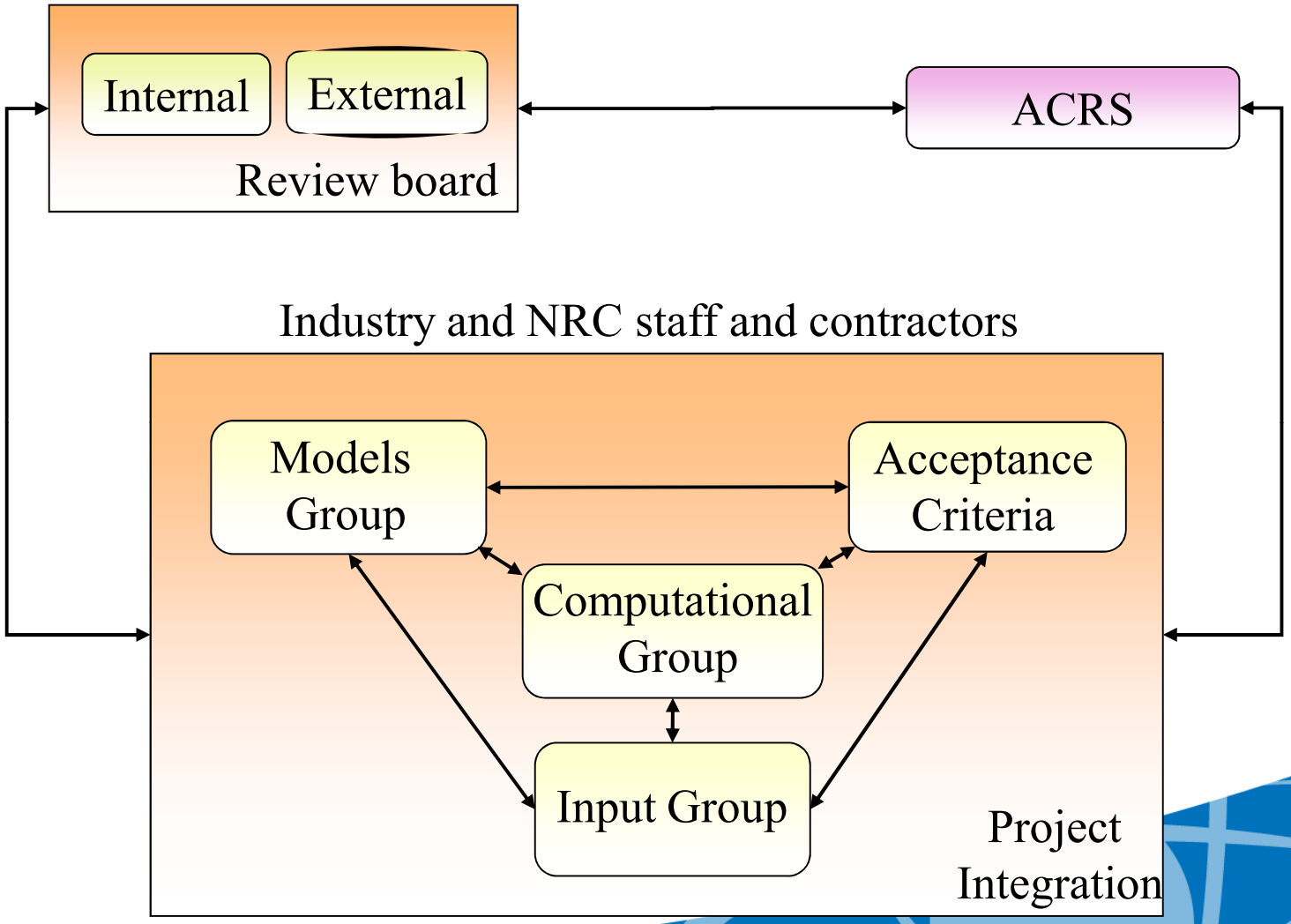


Pilot Study

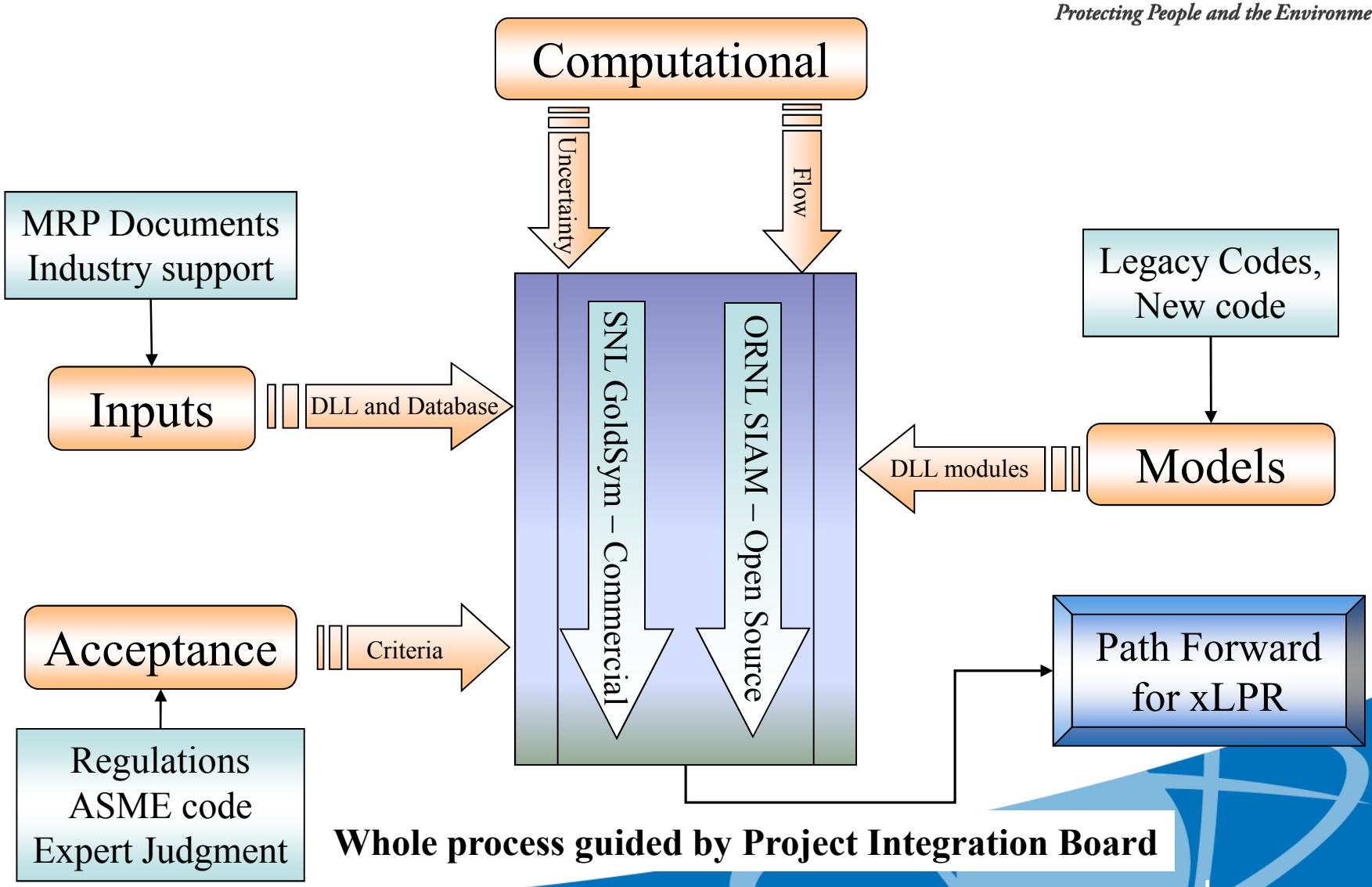
- Assess rupture probabilities of pressurizer DM welds since vast publicly available data and information already exists.
  - MRP-216: Alloy 82/182 DM welds, but, not methodology
  - Task groups to assess and select models for short term use in developing initial code
    - Computational Group
    - Models Group
    - Acceptance Criteria Group
    - Input Group
    - Project Integration Group
  - Tasks groups consist of both NRC and Industry participants
  - Demonstrate feasibility:
    - Organizational structure
    - Code framework
    - Concept



Code Group Structure

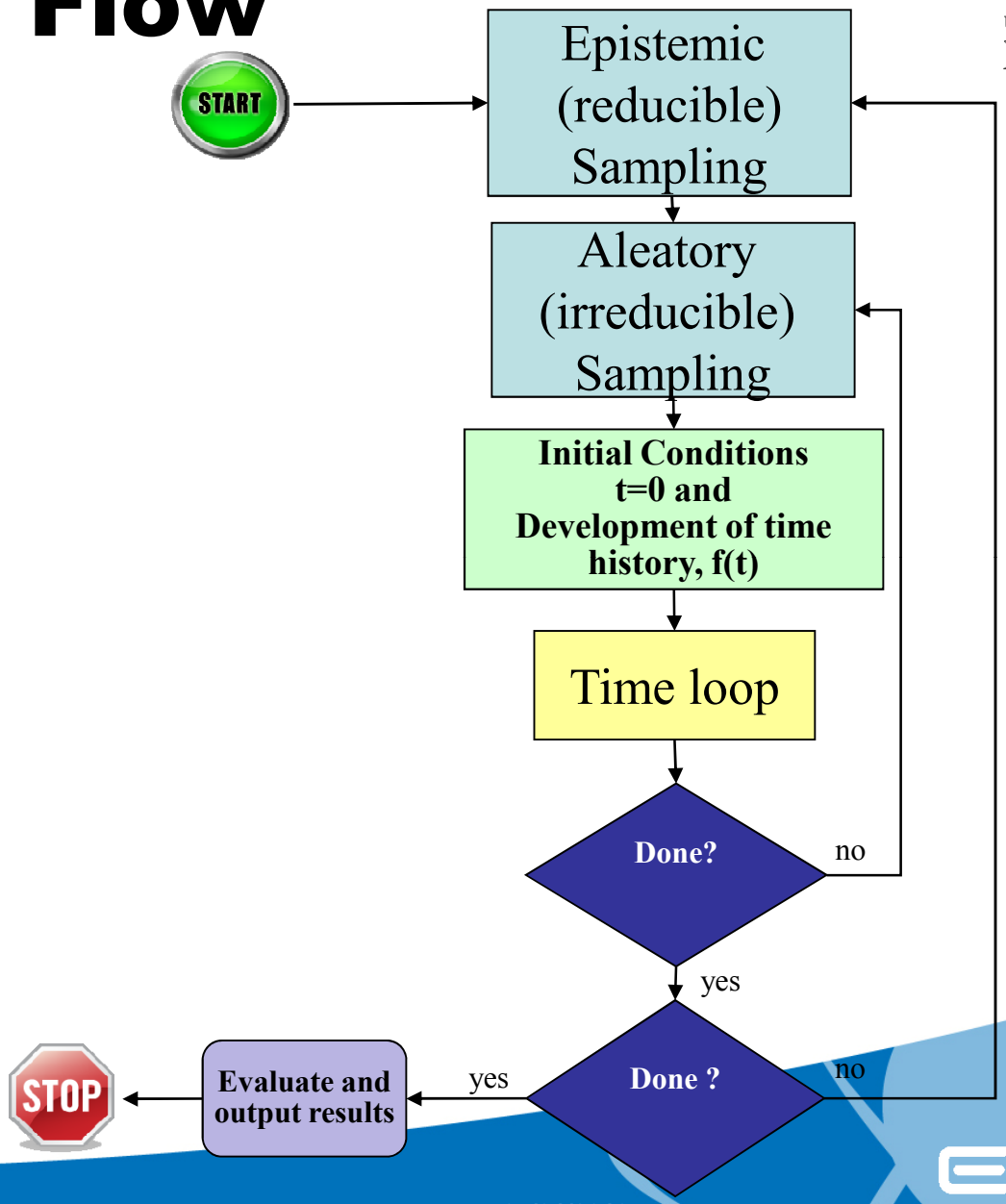


Pilot Study

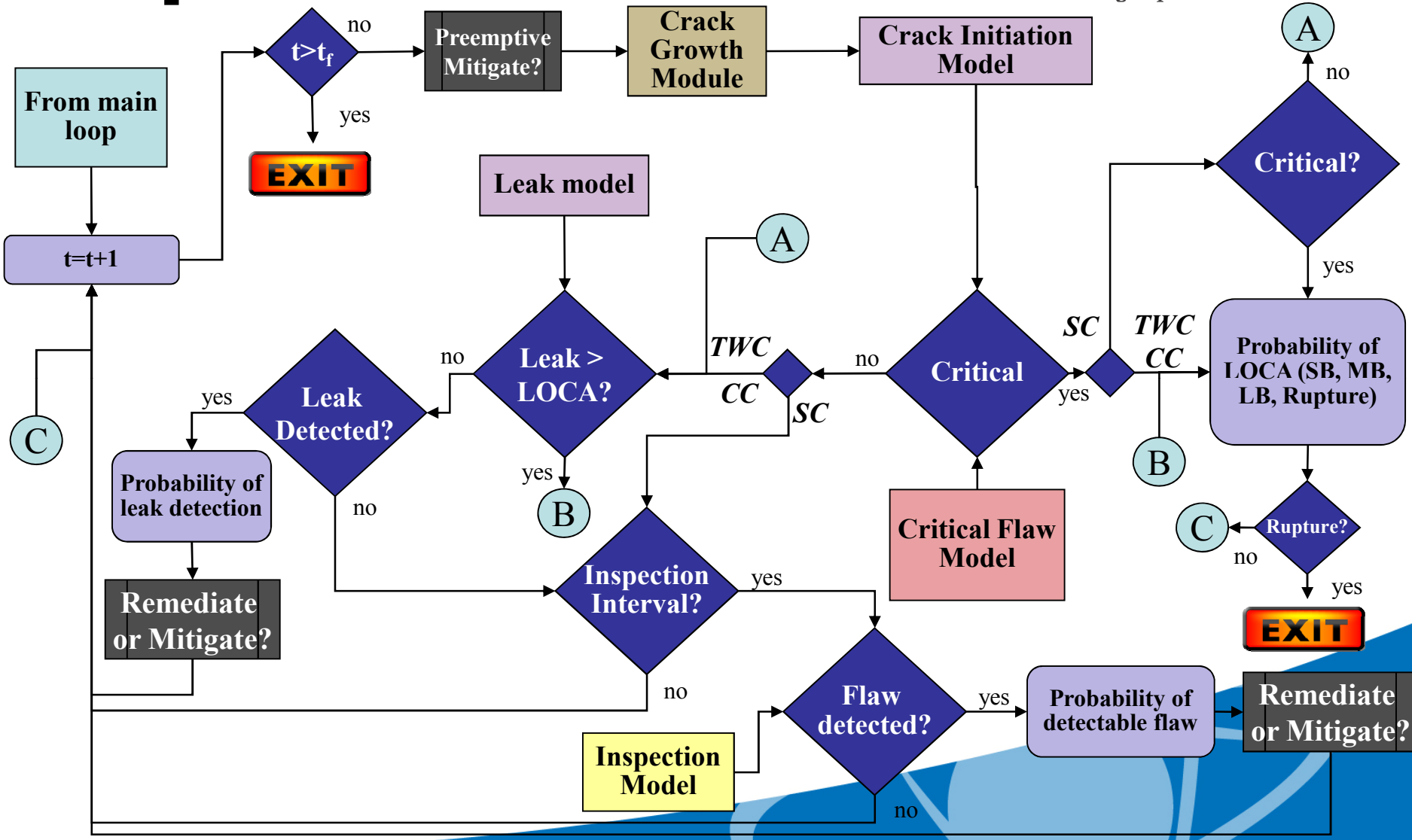


Whole process guided by Project Integration Board

Main Flow


START
Epistemic (reducible) Sampling
Aleatory (irreducible) Sampling
Initial Conditions t=0 and Development of time history, f(t)
Time loop
Done?
no
yes
Done ?
no
yes
Evaluate and output results
STOP

xLPR Approach - Time loop



Uncertainty Treatment

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- Classify the Uncertainty:
  - Epistemic
    - Uncertainty can be reduced or eliminated by improved state of knowledge (e.g., tensile strength)
  - Aleatory
    - Uncertainty cannot be reduced or eliminated by improved state of knowledge (e.g., earthquake occurrence)
- Propagate the Uncertainty:
  - A variable having epistemic uncertainty …
    - Can be represented as a single value in a single pass through the Monte Carlo loop
  - A variable having aleatory uncertainty …
    - Can be represented as a distribution that is carried through the Monte Carlo loop – nested loop
  - Investigating other methods for propagating uncertainty

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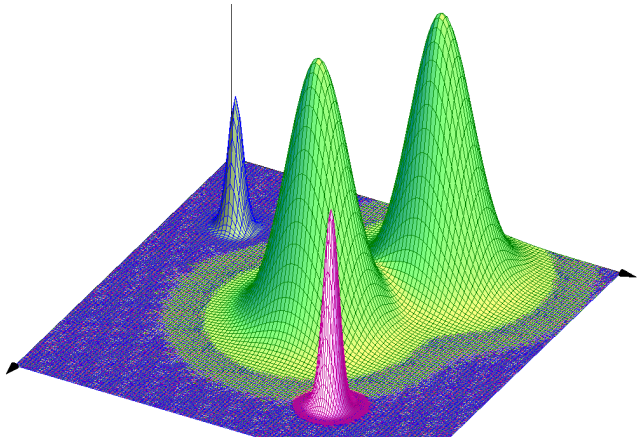
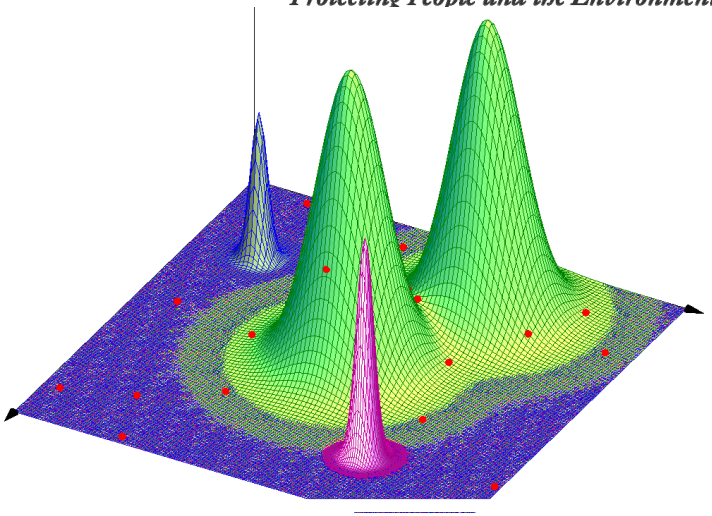
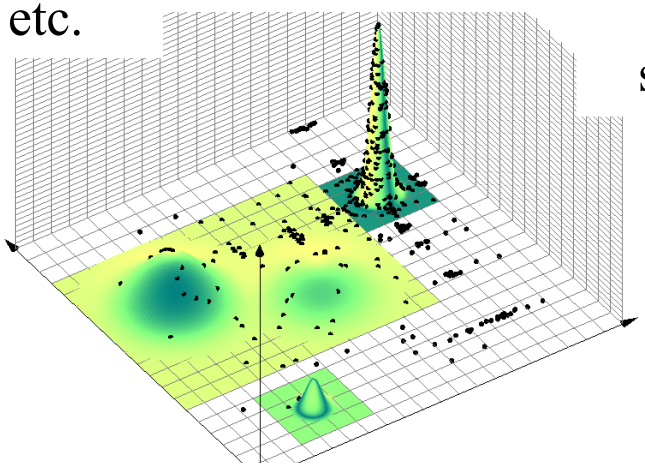
Sampling Techniques



Nuclear piping problem may have a "fractured" response surface due to mitigation, inspection, etc.



Sampling schemes like Latin Hypercube can describe surface but not find peaks



Adaptive strategy is being investigated

Configuration Management and QA

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- Within the pilot study, the structure for configuration management has been developed
  - Released xLPR Configuration Management Plan
  - Setup Sharepoint site for repository of code and documents
  - Currently following plan for initial version of code
- Currently drafting NRC software QA guideline documentation
- Modules are being verified through CM process

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Independent Review and V&V

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- Contracting with Center for Nuclear Waste Regulatory Analyses (CNWRA) who will
  - Develop V&V plan
  - Initial pilot study code V&V
  - Conduct comparison of pilot study codes, i.e., GoldSim versus SIAM using pre-defined metrics
    - **Ease of Use**
    - **Run Time**
    - **User "Friendliness" of Interface**
    - **Flexibility / Adaptability of Software**
    - **Ease of configuration management**
- External review panel under development

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Initial results

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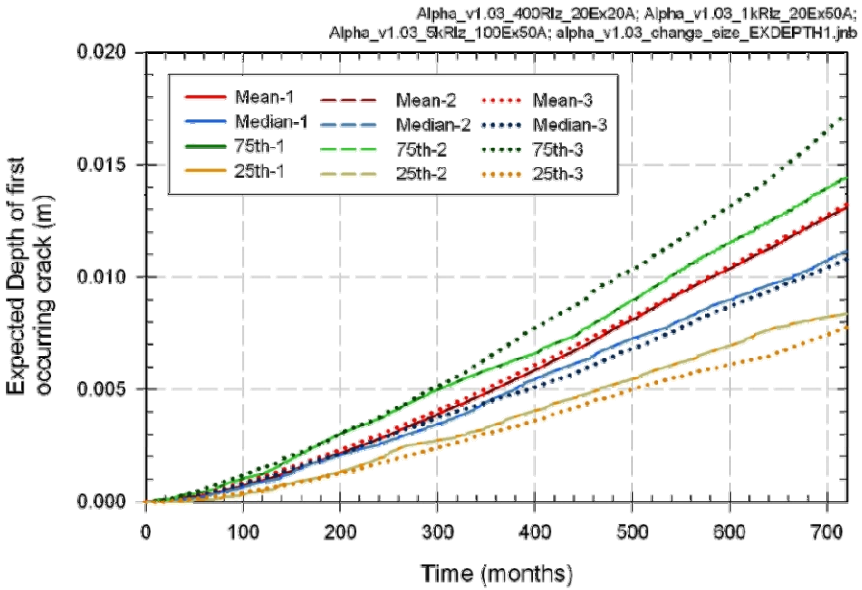

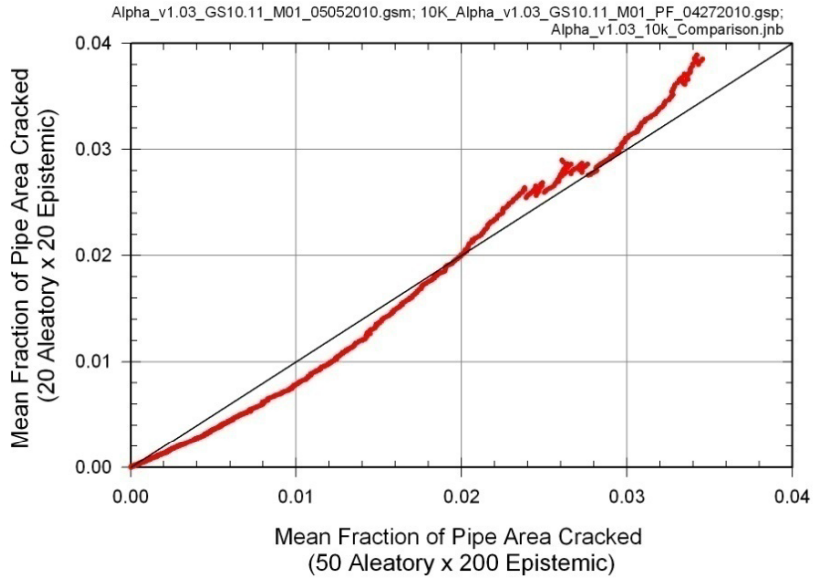

	no inspection		2 inspections (10yr, 30yr)		4 inspections (10yr, 20yr, 30 yr, 40 yr)	
	Prob. TWC	Prob. Fail	Prob. TWC	Prob. Fail	Prob. TWC	Prob. Fail
20 x 20	2.48E-02	1.02E-02	4.32E-04	5.39E-05	2.70E-06	1.21E-07
20 x 50	2.66E-02	1.40E-02	4.86E-04	1.10E-04	5.01E-06	3.30E-07
100 x 20	3.32E-02	2.50E-02	4.25E-03	3.13E-03	6.37E-04	3.68E-04
100 x 50	3.22E-02	2.43E-02	2.35E-03	1.46E-03	6.14E-04	1.44E-04

Current Status/Schedule

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- Initial test version of pilot study code is complete.
- Development of pilot study problem statement underway
- Transition to final pilot study version underway
- General Schedule
  - Pilot Study – Surge nozzle problem – Dec 2010
  - Short Term – xLPR modular code – 2012-2013
  - Long Term – Generic modular Code –2015-2016 – NRC goal

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