



**U.S.NRC**

UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

# **Risk-Informed Regulatory Decision Making**

**Commissioner George Apostolakis  
U.S. Nuclear Regulatory Commission**

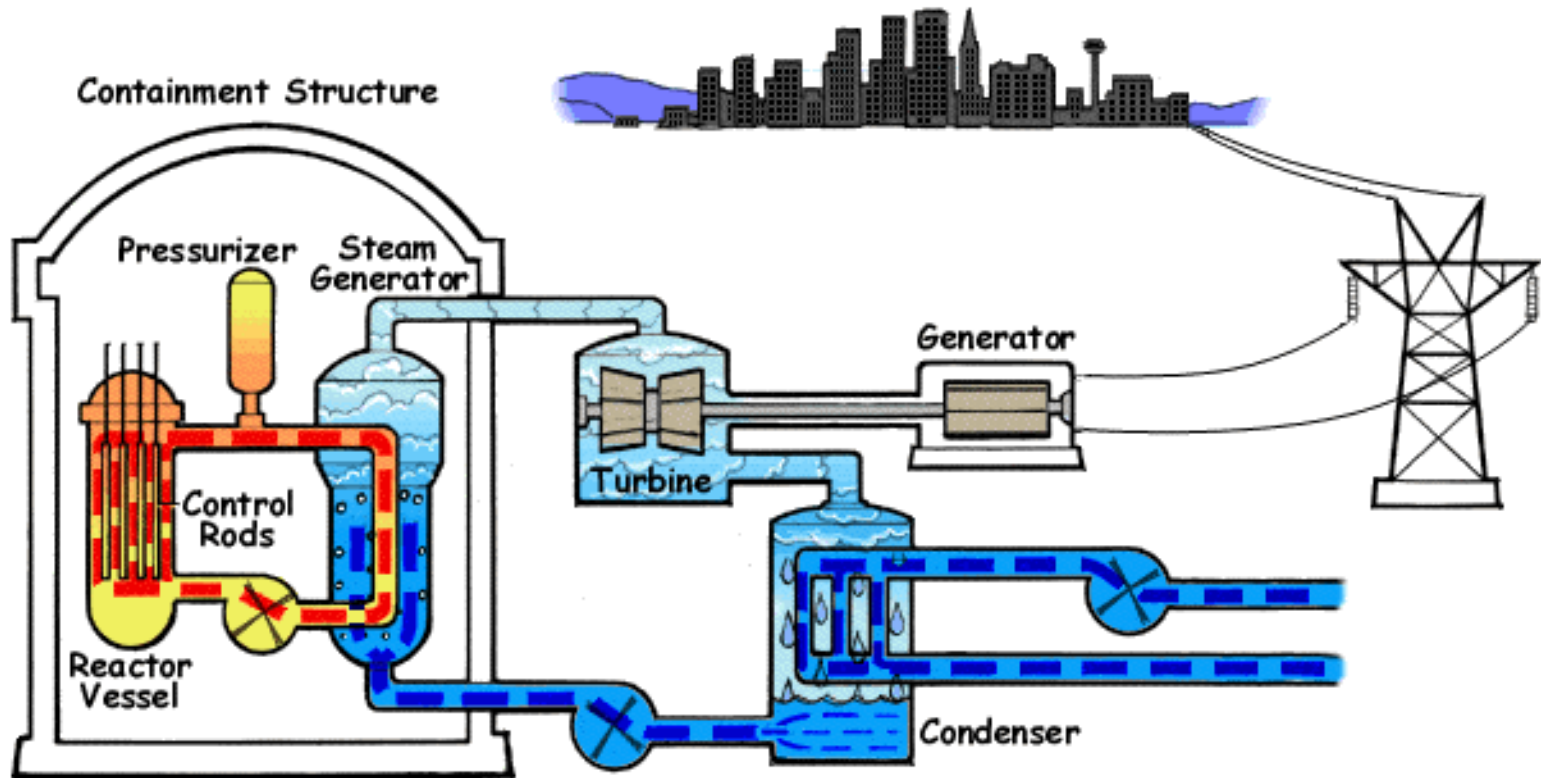
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## The Agency

- **The U.S. Nuclear Regulatory Commission regulates the civilian use of nuclear materials and facilities to ensure adequate protection of public health and safety, to promote the common defense and security, and to protect the environment.**
- **It is an independent agency within the Executive Branch.**
- **It consists of five Commissioners, appointed by the President and confirmed by the Senate, who serve staggered 5-year terms. The President designates the Chairman.**

# Pressurized Water Reactor



## The Traditional “Deterministic” Approach to Reactor Safety

- Management of (unquantified at the time) uncertainty was always a concern.
- Defense-in-depth and safety margins became embedded in the regulations.
- “*Defense-in-Depth* is an element of the NRC’s safety philosophy that employs successive compensatory measures to prevent accidents or mitigate damage if a malfunction, accident, or naturally caused event occurs at a nuclear facility.” [Commission’s White Paper, February, 1999]
- Questions that defense in depth addresses:
  - What if we are wrong?
  - How can we protect ourselves from unknown unknowns?
- How much defense in depth is sufficient?

# Design Basis Accidents

- **A DBA is a postulated accident that a facility is designed and built to withstand without exceeding the offsite exposure guidelines of the NRC's siting regulation.**
- **They are very unlikely events.**
- **They protect against "unknown unknowns."**
- **Example: Large Loss-of-Coolant Accident (LLOCA)**

## **Emergency Core Cooling System (LLOCA)**

- **An ECCS must be designed to withstand the following postulated Loss-of-Coolant Accident (LOCA):**
  - **a double-ended break of the largest reactor coolant line,**
  - **the concurrent loss of offsite power,**
  - **and a single failure of an active ECCS component in the worst possible place.**

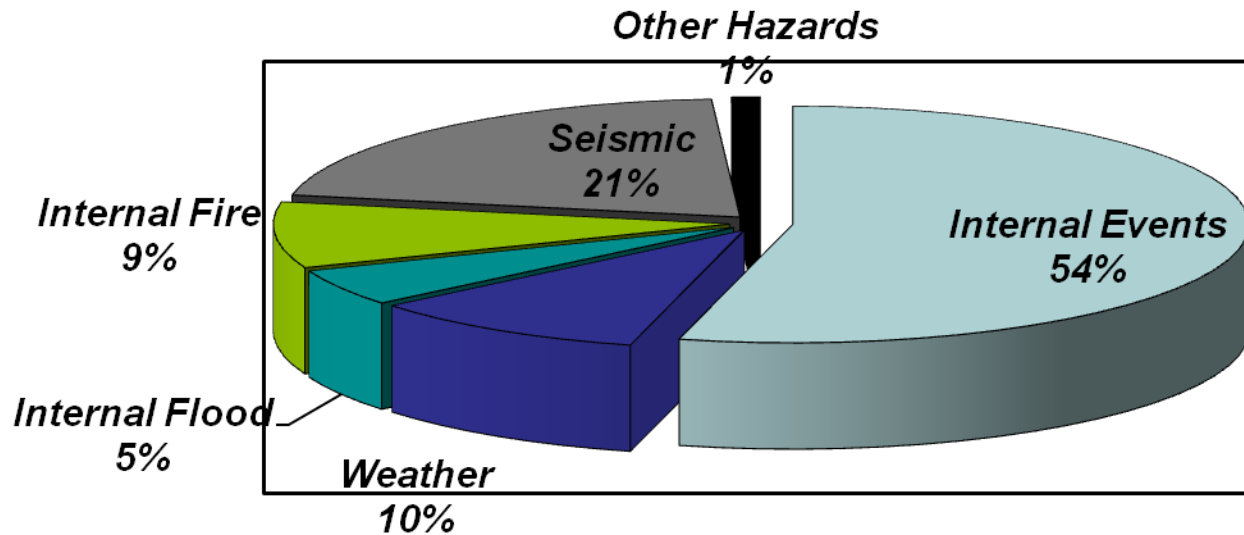
# Technological Risk Assessment (Reactors)

- **Study the system as an integrated *socio-technical* system.**

**Probabilistic Risk Assessment (PRA) supports Risk Management by answering the questions:**

- **What can go wrong? (accident sequences or scenarios)**
- **How likely are these scenarios?**
- **What are their consequences?**
- **Which systems and components contribute the most to risk?**

# Seabrook at Power PRA - Contribution of Initiators to Core Damage Frequency (CDF)



**CDF = 1.45E-5 / yr (mean value)**





# Risk Achievement Worth Ranking

Loss Of Offsite Power Initiating Event	51,940
Steam Generator Tube Rupture Initiating Event	41,200
Small Loss Of Coolant Accident Initiating Event	40,300
Control Rod Assemblies Fail to Insert	3,050
Common Cause Failure of Diesel Generators	271
RPS Breakers Fail to Open	202

## **PRA Policy Statement (1995)**

- **The use of PRA should be increased to the extent supported by the state of the art and data and in a manner that complements the defense-in-depth philosophy.**
- **PRA should be used to reduce unnecessary conservatisms associated with current regulatory requirements.**

## Risk-Informed Framework



### ***Traditional “Deterministic” Approaches***

- Unquantified Probabilities
- Design-Basis Accidents
- Defense in Depth
- Can impose unnecessary regulatory burden

### ***Risk-Informed Approach***

- Combination of traditional and risk-based approaches

### ***Risk-Based Approach***

- Quantified Probabilities
- Scenario Based
- More realistic
- Incomplete
- Quality is an issue (Model uncertainty; Analyst or expert judgment)

**• All risk-informed initiatives are voluntary.**

## How are decisions made?

- **Risk-informed decision making:**

- **PRA results are one input to a subjective decision-making process that includes elements of traditional engineering approaches such as defense in depth.**

U. S. Nuclear Regulatory Commission, *Regulatory Guide 1.174, Rev. 1, 2002.*

- **The Analytic-Deliberative Process:**

- *Analysis* uses rigorous, replicable methods, evaluated under the agreed protocols of an expert community - such as those of disciplines in the natural, social, or decision sciences, as well as mathematics, logic, and law - to arrive at answers to factual questions.
- *Deliberation* is any formal or informal process for communication and collective consideration of issues.

National Research Council, *Understanding Risk*, Washington, DC, 1996.

## Risk-Informed Changes to the Licensing Basis (RG 1.174; 1998)

