#### **Teaching Notes**

# Operational Reactor Safety Course

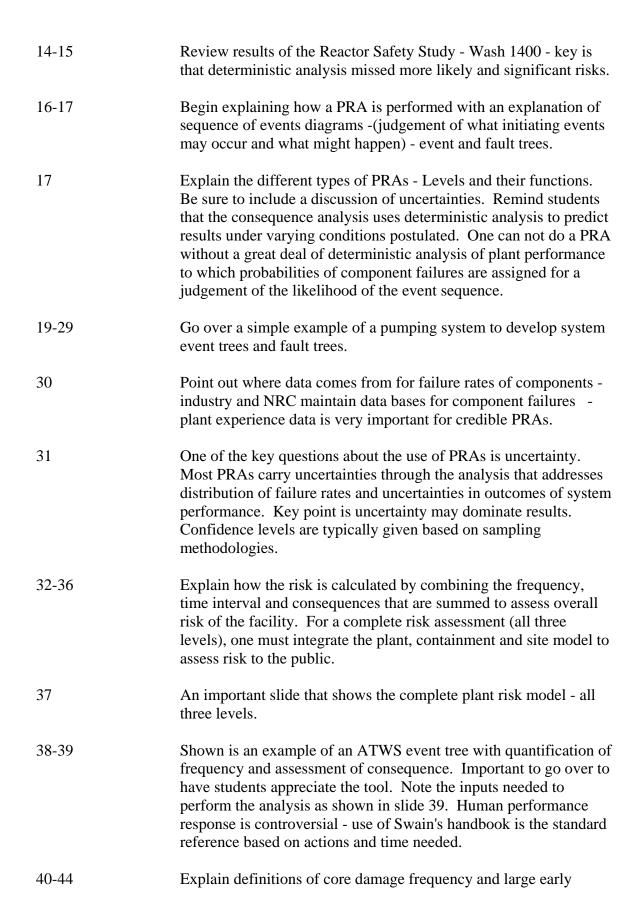
## <u>Lecture: 11 – Probabilistic Safety Analysis</u>

## Objective:

The objective of this lecture it to gain an appreciation of probabilistic risk assessments in design and operation. It is not intended for students to become PRA experts but to understand what PRA is in terms of event and fault trees. NRC use of risk informed decision making is discussed as are safety goals.

## **Key Points to Bring Out:**

Slide number	Points
3-4	Contrast deterministic and probabilistic analysis - key points are that PRAs do not assume systems function with 100% reliability as in deterministic analysis and includes human error. Deterministic analysis attempts to bound system human failures.
5	The purpose of showing this slide is to point out the complex nature of nuclear plants. PRAs need to model all systems that have any influence on the core or heat removal.
6	Review PSA applications noting that the trend in regulatory and design applications - explain what risk informed performance based regulation means.
7	Review history of PRA and why it is a good tool for decision making and design to increase understanding of plant systems and their failure modes.
8-10	Review the basis of the "Farmer Paper" as a methodology for judging acceptable risk results by using credible and incredible accidents.
11-13	Review what goes into a PSA - event and fault trees and how calculated. Summarize historical studies - technology has been in use since 1975 with the Rasmussen Reactor Safety Study.



definition of conditional failure probability. 45-47 Review shutdown risk -which are not negligible particularly during refueling. This may be surprising to students - 43% of the total risk. 48-54 These slides review the NRC's view of risk assessments post the Rasmussen report - key is they walked away from the technology for many years even though the industry continued to perform PRAs on their plants - review results presented to observe variability in core damage frequency. Mention that NRC did eventually require Individual Plant Evaluations - Level 1 PRAs on all plants Mention the use of mean vs. Median results of PRA and confidence limits. 55-58 Review NRC safety goals and bases of subsidiary quantitative safety goals. 59 A good summary of quantitative safety goals as applied to the three levels of PRAs. Don't forget to include uncertainties as a factor. 60-64 Using the United Kingdom's risk tolerance curve, the US evolution of the use of PRA in decision making should be explained. Slide 64 shows how the current Commission is applying risk in regulation.

release frequency which are key indicators of safety of the plant. Point out typical risk contributors in a PWR noting external events

are as important as internal (component) failures. Discuss

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