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Prerequisite: Graduate Standing

Description
The Nuclear Reactor Safety course will examine the basis for reactor safety in commercial power plants. The role of the USNRC, utility and the reactor designer (vendor) in determining the safety of the plant will be discussed. The course will also elaborate on the role of international regulatory bodies, how same principles are followed and what are the difference in implementation of the rules. The safety systems which have been installed on plants will be discussed as well as how postulated accidents and events are classified. The general design criteria, design acceptance criteria are introduced and the mechanism for the licensees to demonstrate compliance with the rules will be presented. Different type of accident transients will be analyzed as well as the evaluation models used today by the industry for such analyses will be presented.
A review of the lesson learned from the three major accidents in the history of the nuclear industry (Three Miles Island, Chernobyl and Fukushima) will be provided.
In the last part of the course a review of advanced plant designs (Light Water Reactors) adopting passive safety features will be presented as well as the status on construction of these plants in the world.

Organization
Text:
1. Class Notes and Handouts
   Notes and papers will be provided for each lecture

The course will be offered through distance education and will be open for both resident and distance students.
**Course Objectives**

The objective of the course is provide the students an understanding in how the safety of the nuclear installations is ensured within the industry, starting from principles of safety culture and defense-in-depth. The students will familiarize with the regulatory requirements and how postulated accidents are classified and analyzed to demonstrate adequacy of the safety systems build in the designs.

**Course Grading Plan**

The suggested grading is based on the following:

- 20% homework (approximately one homework per week)
- 10% mid-term project
- 40% timed quizzes
- 30% term paper

The period for the quizzes (four in total) is given in the course outline and they are NOT accumulative but will cover the portion of the course identified. Instead of a final exam, each student will be assigned (or agree upon) a safety issue of importance around which developing a comprehensive term paper. The instructor will provide a list of current safety issues. The student will make a formal presentation before the class and interested faculty on his/her paper.
Course Outline

Week 1
- Course outline, grading, homework, expectations, projects
- What is safety, what it means
- Public perception toward risk
- Safety culture and defense in depth – IAEA Safety Guides

Week 2
- USNRC Organization, history, charter and responsibilities
- General Design Criteria and Safety Analysis Report
- Licensing process in the US, roles and responsibilities
- International regulatory bodies

Week 3
- Licensing process (cont.): the Standard Review Plan (SRP, NUREG-0800)
- The Safety Analysis Report (SAR)
- The license amendment process
- Operability and reporting requirements
- The design certification process (new plants) (10 CFR Part 52)
- Rulemaking process

Week 4
- Licensing process (cont.): the Standard Review Plan (SRP, NUREG-0800)
- Regulatory Guides
- Examples: Regulatory Guides 1.157 and 1.203
- The Evaluation Model Development and Assessment Process (EMDAP, RG 1.203)

Quiz 1, closed book

Week 5
- Accidents classification
- PWR and BWR design basis accident (Loss of Coolant Accident, LOCA)
- Passive Plants (AP1000) and SMRs

Week 6
- PWR core limits and operating space
- PWR safety system design (RCS and Containment)

Week 7
- PWR transient analysis (simplified core and system approach)

Week 8
- PWR steam generator tube plugging
- Discussion of project results
- PWR safety system design (RCS and Containment)
- PWR transient analysis (simplified core and system approach)

**Quiz 2, closed book**

**Week 9**

- LOCA history, why a LOCA
- The LOCA compendium (NUREG-1230)
- PWR LOCA

**Project assignment: A simplified Large Break LOCA Analysis in a PWR**

**Week 10**

- Review of Realistic LOCA Evaluation Models in the industry
- 10 CFR 50.46 reporting requirements

**Week 11**

- BWR transient analysis
- BWR LOCA

**Week 12**

- Accidents that have occurred
  - TMI
  - Chernobyl
  - Fukushima

**Quiz 3, closed book**

**Week 13**

- Beyond Design Basis Accidents (or DBA extention)

**Week 14**

- AP1000

**Week 15**

- ESBWR
- Small Modular Reactors
- Recap, future issues

**Quiz 4, closed book**

**Presentation of student papers on current or important safety issues**