

Chemical Engineering 612

Nuclear Reactor Design and Analysis

Introduction, Project Scope



Hard Work + The Spirit

Face the future with optimism. I believe we are standing on the threshold of a new era of growth, prosperity, and abundance. Barring a calamity or unexpected international crisis, I think the next few years will bring a resurgence in the economy as new discoveries are made in communication, ***medicine, energy, transportation***, physics, ***computer technology***, and ***other fields*** of endeavor.

Many of these discoveries, as in the past, will be ***the result of the Spirit whispering insights into and enlightening the minds of truth-seeking individuals***. Many of these discoveries will be made for the purpose of helping to bring to pass the purposes and work of God and the quickening of the building of His kingdom on earth today. With these discoveries and advances will come new employment opportunities and prosperity *for those who work hard and especially to those who strive to keep the commandments of God.*

This has been the case in other significant periods of national and international economic growth.

-Elder M. Russell Ballard

BYU Idaho Commencement Remarks

April 6, 2012



Family



Course Details

- Weekly Homework (25%)
 - Late homework accepted for 1 week at 50%
 - Includes 2 “Coding” Homework Assignments
- 2 Midterm exams (30%) Take-home, open book, computer, notes, etc. (no internet)
- Final Project (45%):
 - Final Report due last day (4/15)
 - Final Presentation – last day of class (4/15)



Textbook

- All Material will be presented and included on slides, but content is taken primarily from 3 sources:
 - 1) *Introduction to Nuclear Engineering 3rd Edition*, John. R. Lamarsh & Anthony J. Baratta, Prentice Hall, 2001.
 - 2) *Nuclear Systems I Thermal Hydraulic Fundamentals*, N. E. Todreas, M. S. Kazimi, Taylor & Francis 1993.
 - 3) *Nuclear Reactor Analysis*, J. J. Duderstadt, L. J. Hamilton, John Wiley and Sons, 1976.



Homework

- Weekly Homework Assignments (most often midnight Fridays),
 - understanding of fundamentals of design and licensing
- 2 coding based homework:
 - OpenMC (Neutronics)
 - Design problems and manipulation of existing input deck.



Exams

- There will be 2 midterm exams:
 - Friday, Feb 13th
 - Friday, March 11th
- Each will be open book, open notes
 - Can use Computer (don't print python code)
 - No internet
- Unless there is a MAJOR reason, do not ask to miss and make up the exam



Project

- Purpose is to design viable reactor concept
- Due last day of class (4/15)
 - Presentation on the design, operation, safety, licensing, and maintenance of the reactor
 - 1 group paper with detailed description of reactor operation, maintenance, safety, and performance (20+ pages)
 - 1 design paper (5 pages) which describes the basic design concept
 - Grades based on technical accuracy, satisfaction of design requirements, and safety performance/features



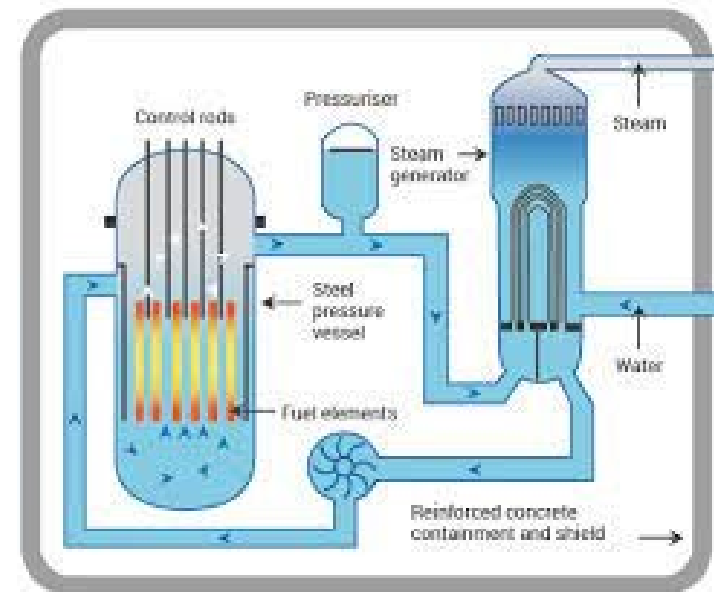
Large Engineering Projects

- Requires many focused sub-groups
 - Each covers specific task
 - Project managers
 - Program managers
 - **INTEGRATION IS KEY CHALLENGE!**
- e.g. submarines



Project Organization

- Often divided into SSC's:
 - Systems
 - Structures
 - Components
- Interface of groups is challenge
- Mitigation of risk is strong focus
- Economics
- Sooo large... how to organize/start?



Functional Design Requirements

- Outline what SSCs are supposed to do
- Basic, fundamental operation
- Encapsulate entirety of function
- Consider all modes of operation

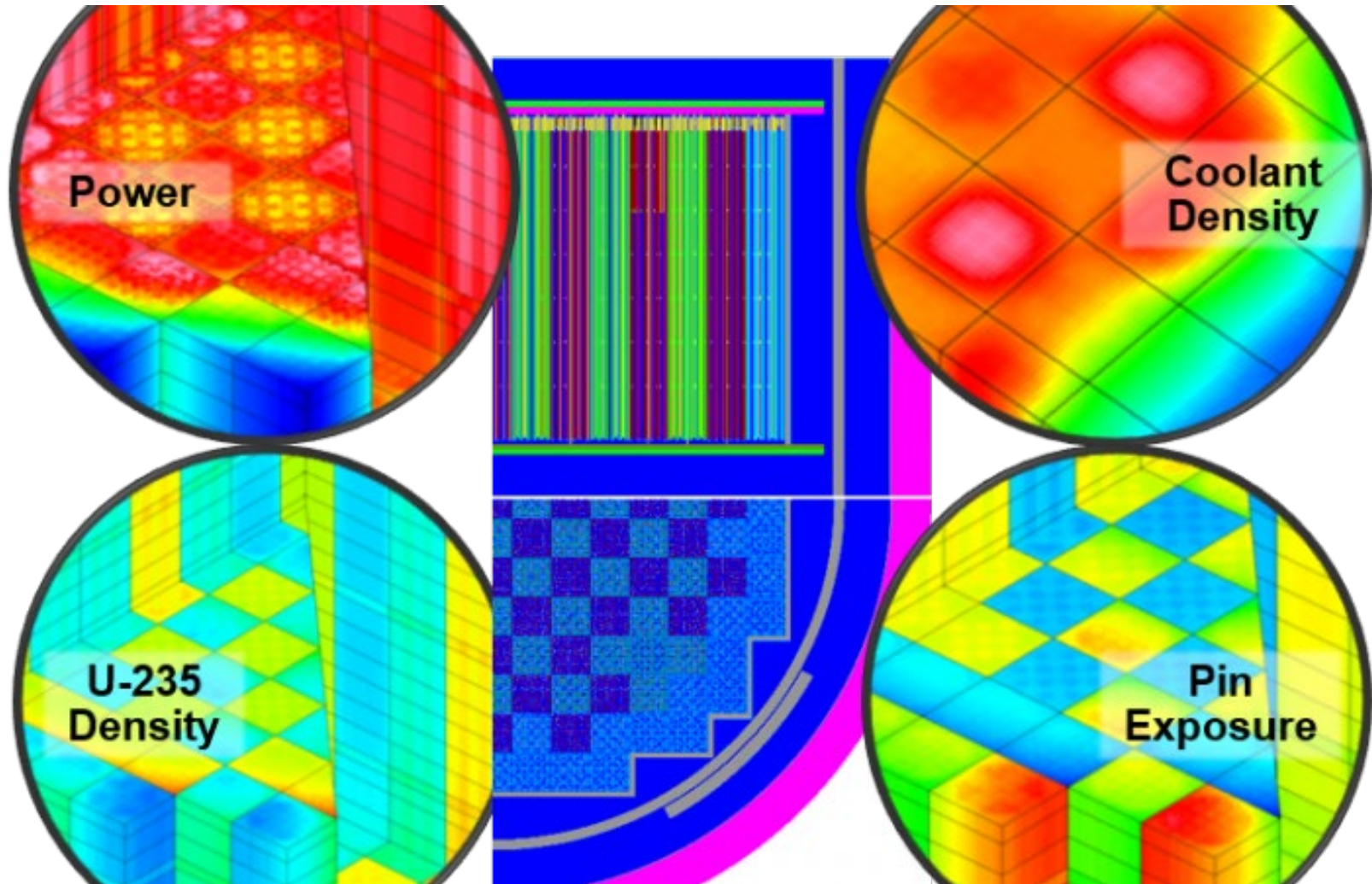


Reactor Design Strategy

- Using Functional Requirements:
 - Start with basic design (Hand calcs)
 - Where appropriate, couple hand calcs
 - Neutronics
 - Heat transport
 - Fluid Transport
 - System Thermodynamics
 - Structural Mechanics
 - Corrosion
- Slowly relax assumptions
- Move to computational analyses
- Multi-physics modeling



Multiphysics → Multiscale



Safety Requirements

- Once functional requirements are completed
- Additional requirements:
 - Operational safety
 - Expected transient performance
 - Accident safety
 - “What-ifs”
- Generally can be added to functional requirements

• Computational Translation? PRA



Example – Table Saw

- Functional Design Requirements?
- Modes of Operation?
- Safety?

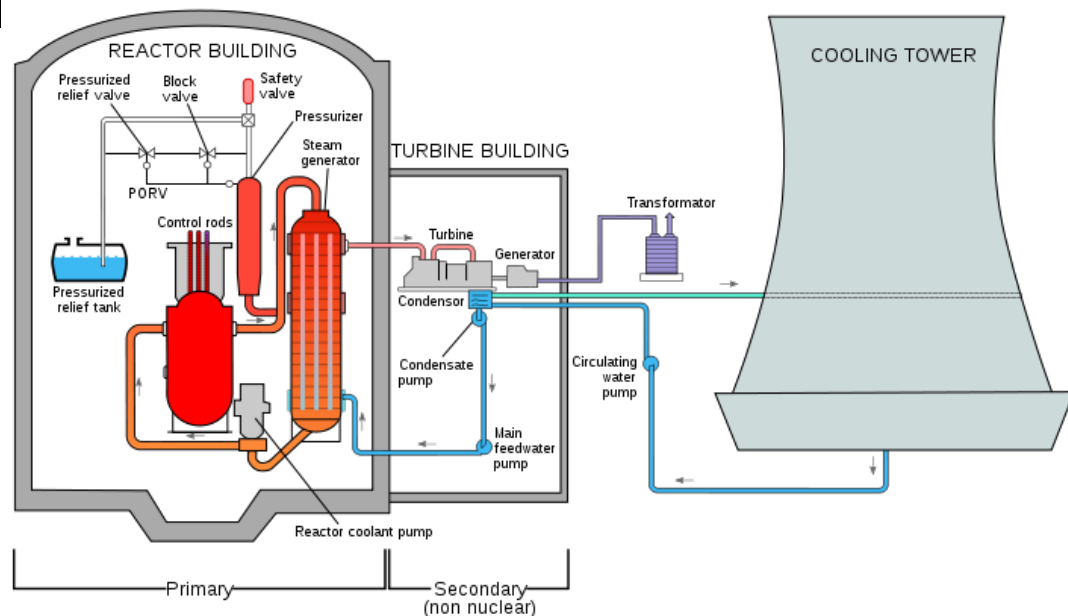


Table Saw Safety (Accidents)



Nuclear Approach

- Safety requirements can conflict!
- Adding to completed design insufficient
- Must be incorporated into design upfront
- Example: three mile island
 - LOCA vs. overfill



Groups?

