For Senior Design, you are asked to complete a comprehensive design project. It is intended to tie together your nuclear engineering knowledge with your engineering design expertise through an independent analysis of design considerations for a nuclear system of some kind.

Topic Examples

For your guidance, a list of example topics appears here. Feel free to choose one of these. However, choosing a creative topic of your choice is encouraged. This section may be expanded if I have new ideas as the semester progresses.

Front End Fuel Cycle Support for Advanced Reactors Many new reactor design ideas have peculiar fuel needs (TRISO particles, doubly heterogeneous TRISO pebbles, liquid salt fuels, higher enrichments). What technology gaps currently exist & can you solve them? Note that currently, many of these involve processes that are prohibitively expensive. Some raise proliferation concerns as well.

^7Li Isotopic Separation Isotopic separation (a.k.a. enrichment) of Lithium 7 is necessary for appropriate neutronic behavior in an FHR or MSR. How expensive will it be for some of these reactors and what are the neutronic impacts of ^6Li impurities in such a reactor? Can you balance performance and cost by designing a salt reactor less sensitive to ^6Li?

Creative Enrichment Applications Some enrichment technologies allow for enrichment of more than just uranium (for example, plutonium, boron, nickel, etc...) what clever uses of enrichment technology might improve our world? What isotopes might you separate? How would that work? What enrichment methods would you use? What would the separation efficiencies be? How much money would you make? What would you do with the tails? Is there a market?

Cheaper Reprocessing How can pyroprocessing be made 10x cheaper than today's PUREX? How can PUREX be made less expensive than it is now?

Impact of a Zero Emissions Tax Credit New York state recently (summer 2016) implemented a zero emissions tax credit. It was enough to save the Fitzpatrick nuclear generating station. Were the parameters of that state-level to be implemented accross the US, either federally or individually in each state, the risk of owning and building nuclear plants would decrease. Quantify the change in risk. Predict the impacts to the nuclear industry. Would it be enough to save at-risk plants? Would we likely see an increase in new builds? What other impacts might we see?

The Likelihood and Implications of the Duck Curve The California Independent System Operators published the "duck chart." This curve, describing the predicted mid-day overgeneration of grid-bound electricity, caused by installations of solar, primarily, makes load-following generation sources or storage methods necessary. A few questions that would make interesting projects on this topic include:

- What is the level of alarm appropriate in reaction to this chart and why?
- Can you suggest a novel strategy that would allow nuclear generation to be adapted to load follow?
- What would the impact to nuclear power be if this situation is allowed to proceed and there is no curtailment of variable generation sources?
- How could current storage technologies smooth this curve?

Liquid vs. Solid Fuelled Molten Salt Reactor Source Term and Release Pathways Reactor designs involving molten salts can have either solid fuel or fluidized fuel. In the fluid fuel case, proponents are often heard to say they can't melt down because they operate safely at a melted state. Compare the source term and release pathways of a containment breach in a solid fuelled salt reactor vs. a fluid fuelled one.

Economics of Uranium Extraction of Seawater A great deal of research is being undertaken to lower the costs of uranium extraction from seawater. Can you replicate the results of a previous calculation of those costs? To what extent are those results sensitive to uncertain assumptions (assumptions of a political, technical, or economic nature, it matters not.)

Metrics for Proliferation in the Nuclear Fuel Cycle Suggest a metric that captures proliferation concern in a nuclear fuel cycle scenario.

Assessment of Dose To Workers in Reprocessing Schemes Propose a model for calculating the dose impact on workers within an arbitrary fuel cycle. Include dose due to all steps of the fuel cycle, including reprocessing and disposal. Compare and contrast fuel cycle strategies with and without reprocessing.

Fuel Cycle Transition Scenario Choose one of the Evaluation Groups identified by the Fuel Cycle Options Evaluation and Screening. Use a simulator (e.g. Cyclus, CLASS, or Orion) or your own model to assess the time-to-transition from our current reactor fleet to 100% deployment of the new technology (e.g. SFRs, MSRs, etc.)

Repository Cost Estimation Suggest a high level waste repository site. Suggest appropriate waste forms, waste packages, and other disposal system design features for this geology. Estimate construction rates, loading rates, transportation costs, and a closing timeline. With these estimates, defended by analysis, conduct a life cycle cost estimation of your proposed site.

References

[1] Charles W. Forsberg. External Breakthrough Technologies for Salt-Cooled Reactors. *ANS Transactions*, 109(1):Pages 1075–1078, November 2013.