Exam 4: NE533: Nuclear Fuel Performance

Show your work. Point values are indicative of the depth of expected response. Check units.

1. (20 pts) A ZIRLO cladding tube is in reactor at 625 K for 400 days. The initial wall thickness is 500 μm.
2. Estimate the oxide thickness after this time?
3. Assuming the hydrogen pickup fraction is 18%, what is the weight PPM of hydrogen in the cladding after one year? Assume PBR = 1.56, ρZr = 6.5 g/cc, ρZrO2 = 5.68 g/cc.
4. (4 pts) What is the rate-limiting step in the aqueous corrosion of Zr cladding?
5. (4 pts) What is the Pilling-Bedworth ratio? What does it tell us?
6. (12 pts) Where do hydrides form in the cladding? Why? What impacts do hydrides have?
7. (12 pts) What is a RIA? What is a typical RIA in a PWR or BWR. Describe what happens during a RIA.
8. (10 pts) What is a LOCA? How is it different than a RIA?
9. (6 pts) What are two of the pathways to make the fuel/cladding system more accident tolerant? Provide an ATF option being considered that targets one of these pathways.
10. (6 pts) What happens to zirconium cladding when it is exposed to high temperature steam?
11. (4 pts) Provide an option for improving the steam oxidation resistance of LWR cladding.
12. (6 pts) List and describe two examples of limiting phenomena governing LWR operation.
13. (6 pts) What is CRUD? What fuel performance and safety impacts does CRUD have?
14. (6 pts) List two water chemistry controls that have been implemented in LWRs, including why they were implemented.
15. (9 pts) What are some of the key differences in MOX fuel compared to LWR fuel? Emphasize differences in in-reactor behavior/performance/environment.