CRITICAL REACTOR LABORATORY QUIZ, 1975

1. Why are the BF_3 detectors used only as startup channels? Why is it necessary to calibrate them?

2. What is the purpose of the neutron source?

3. Why does the neutron count rate go down when the moderator is out and the source is removed from the paraffin-shield and driven down into the core region?

4. What is K_{eff} when M=100?

5. What importance do delayed neutrons have in our operation?

6. Draw the three typical curves found on a 1/M vs. fuel mass plot and identify each. Which curve is most valuable for a core loading experiment? Which is best for a subcritical multiplication experiment? Why?

7. What type(s) of radiation might you be subject to while handling fuel elements? List in order of importance?

8. While starting up the reactor (while still subcritical) you notice a positive period. Explain.

9. What is excess reactivity? What information do you need to calculate the excess reactivity?

10. As the operator how would you ascertain that the reactor is critical?

11. What is the temperature coefficient (approximately) between 65°F and 70°F? Why?

12. We observed a change in reactivity when adding B^{10} or Void to the core at 10" on the plastic stringer in position 44. Explain why this reactivity change was experienced (use criticality equation).

13. Why is Beta effective here different from the Beta value for U^{235}? Explain how Beta effective could possibly change over the lifetime of a power reactor core.

14. Why do we not use C.I.C.'s? How do they work?

15. You are prompt critical. Houdini removes the delayed neutrons. What happens? How does the response on our Period Meter change?

16. The pube source emission rate is 10^7. After completing the flux experiment you know the approximate average flux in the core is also near 10^7. Yet at power the source has no noticeable effect. Why?

17. Where in the core did we see the Fuel (HOT SPOT)?

18. At what power level could you operate if control rod #3 was inoperative below 15 inches?

19. As the operator, discuss your actions upon noticing the activation of an automatic scram signal.

T-F Section

20. In the flux mapping experiment, a table of decay factors was provided. What exactly is decaying?

21. In a Boron experiment you are appointed to move the Boron tape from one stationary element to another. After shutdown, you remove one element. Upon surveying, you find the meter is pegged on the (MR/HOUR) scale. What do you do?

TF 22. In an overmoderated reactor, the void coefficient can be positive, even without a central water gap.

TF 23. The energy released in U^{235} fission is about 476 MeV.

24. Comment on this course, the instructors, and the graders. If you feel hostile feel free to use a separate, unsigned sheet of paper.

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44/46 good job

1. BF_3 channels become saturated at high fluxes since they were designed to be very sensitive for startup. Must be calibrated to respond only to neut's, since there is high γ flux even when shutdown.

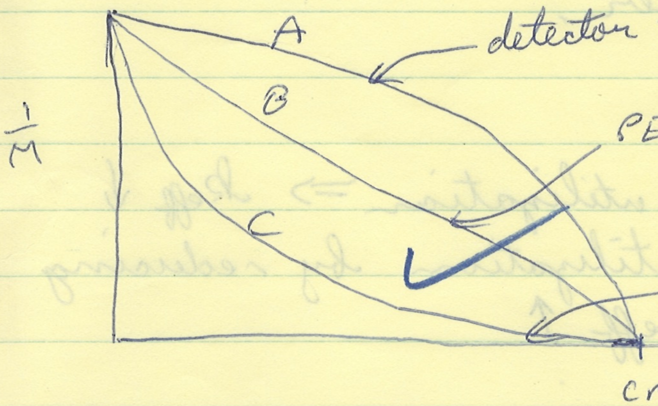
2. Source there to give good counting statistics on startup channels. Also important for safety since if neutron population very small, it would be possible to ~~wd~~ withdraw rods to supercritical position before count rate became large. Also need 2 counts/s on startup channel to drive rods.

3. Because detectors more sensitive to thermal neuts & ~~they~~ are moderated in the paraffin. ~~but~~

4. .99

5. They are important for safety since ~~they~~ they provide a means of ~~increasing~~ controlling the flux increase. Also limit shutdown rate.

6.



A — detector too close to source

B — PERFECT GEOMETRY, count rate ∝ M

C — detector too far from source

C is best for core loading since it is most conservative

B is best for subcrit mult. since detector gives true indication of the multiplication

7. γ – from decay of fission products
n – from source if it is not in tank
β, α – only if cladding failure.
OK

8. The period meter contains a differentiating circuit whose output is proportional to rate of change of count rate. As rods are withdrawn count rate increases and meter reads positive period, although by definition it is not. good

this actually referred to amount of react. available beyond critical

9. $\rho_{ex} = \frac{k-1}{k}$. Need to know stable positive period since ρ_{ex} is related to T by inhour eqn. OK

check to see if count rates remain same
10. Remove the source 1, or move a rod down or up & look for negative or positive period.

11. positive, small; density change of H_2O causes the overmoderation to decrease. This reduces parasitic absorbtion in water.

12. $k_{eff} = pf\epsilon\eta P_F P_{TH}$
a Boron – decreases thermal utilization ⇒ k_{eff} ↓
b Void – increases thermal utilization by reducing absorbtion in H_2O, k_{eff} ↑

13. The delayed neutrons are emitted at much lower energies than the fission neutrons. By examining adjoint flux can see that adding a thermal neutron is more important than

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adding a fast. The delayed neutrons are weighted therefore, since in reactivity equation they ~~are~~ have greater effect per fraction than prompt neuts. $\beta_{eff}\downarrow$ in power reactor due to Pu production, where $\beta \approx .0025$

−1

14. CIC contain an ion chamber sensitive to only γ's in addition to the BF_3 part sensitive to n's & γ's. The γ only chamber is biased against the BF_3 chamber to yield a count rate which is due only to neutrons. Since γ flux is proportional to fission rate in steady state, there is no need to discriminate against the γ's so compensation not used

good

15. The delayed neutrons have no effect in a prompt critical condition since power increases by factor of e in a time which is much smaller than λ_e. If you are exactly prompt critical w/o delayed neutrons (none present) flux will remain stable (non-increasing/decreasing). If delayed neutrons ~~sudd~~ only removed in prompt critical condition Period goes from $\sim 10^{-3}$ sec to ∞. you're first impression correct

if you are prompt critical, who needs delayed neutrons

16. Only a fraction of neutrons from PuBe source contribute to chain reaction due to $1/r^2$ flux decrease and absorbtion. If source ~ 1m away from center, flux due to PuBe (w/o absorbtion) would be about 10^3 n/cm²-s so it contributes less than .01 % to flux.

OK, but remember source ⇒ $10^7 \frac{n}{sec}$ flux ⇒ $10^{?} \frac{n}{cm^2\text{-}sec}$

17. Element 34 plate ~~2~~, ~~10~~ 12"

18. I don't know exactly, it might be possible to go supercritical with rod 3 at 15" in which case you could pick your power but it should ~~not~~ be done. Should ~~should~~ shut down, investigate to determine failure mode, make necessary repairs modifications. good

19. ~~1. Locate cause of scram. 2. If~~
1. Make sure flux/power drop. + rods
2. Locate cause of scram
3. If ~~applicable~~ appropriate reset and refill core
4. List scram in log. good

20. fission products

21. change to R/hr scale

22. TRUE (try measuring it though) I'll say

23. FALSE

24. I think labs should be read + explained a week in advance since some experiments could be modified by us to be more interesting or better planned if they were prepared in advance. Lab reports are a necessary evil. As much as I hate writing them, they force ~~me~~ me to tie theory + knowledge together.