

Nuclear Reactor Core and Fuel Loading Pattern Demonstration

What's the science?

Fuel enrichment

Uranium is the fuel used in nuclear reactors, but there are several isotopes of uranium. Natural uranium contains mostly U-238 with only 0.7% U-235, but nuclear reactors need much more U-235.

Through a process called enrichment, engineers increase the percentage of U-235 to 3-5% of the uranium. Now, it can be used in a reactor. As the fuel burns up, the U-235 is consumed.

Fuel loading patterns

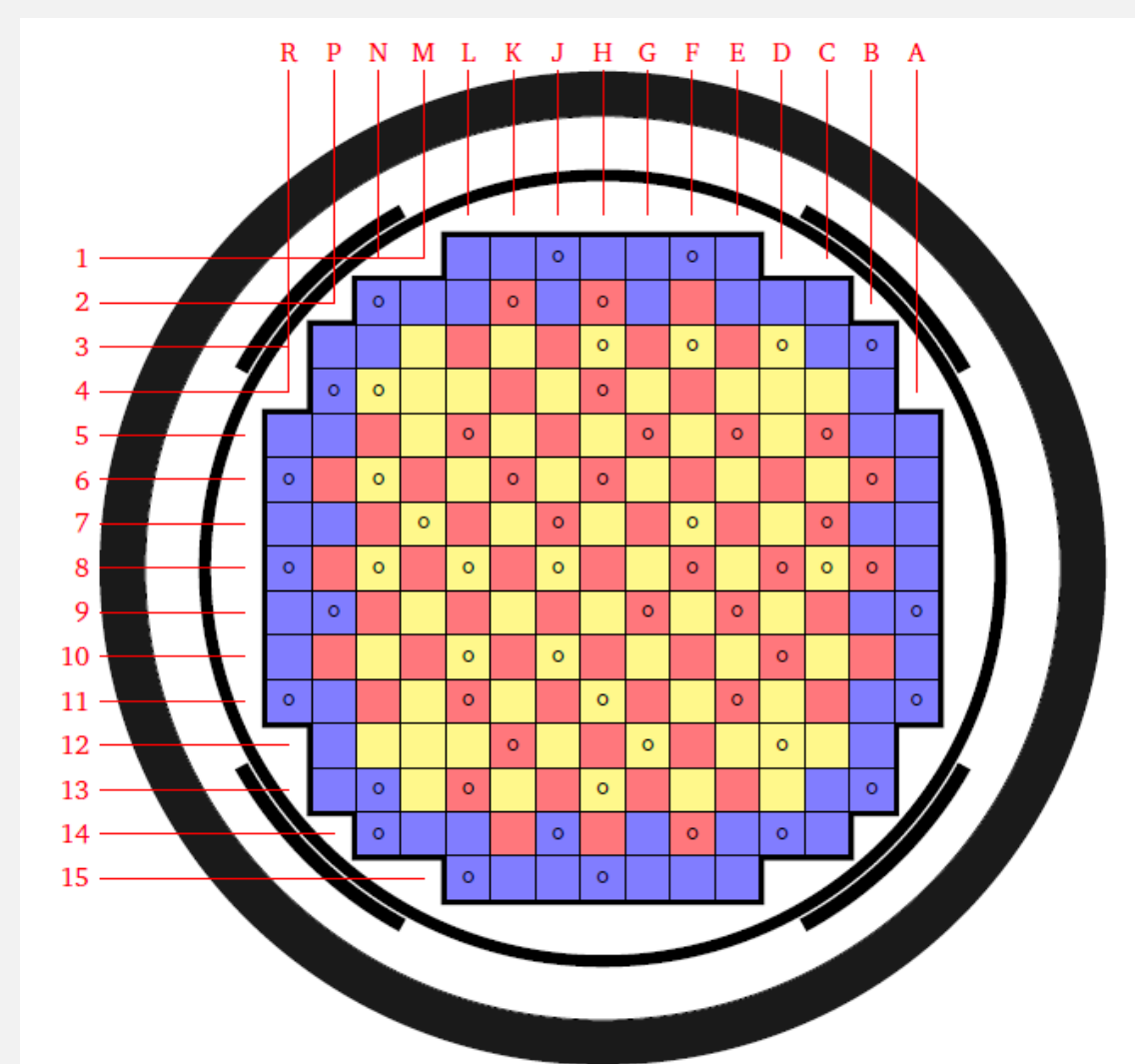
The reactor is most hot in the center of the core, so more U-235 will burn up in the middle than at the edges of the core. To compensate for this, the core is loaded with higher enrichment uranium on the outside, and lower enrichment on the inside.

Refueling

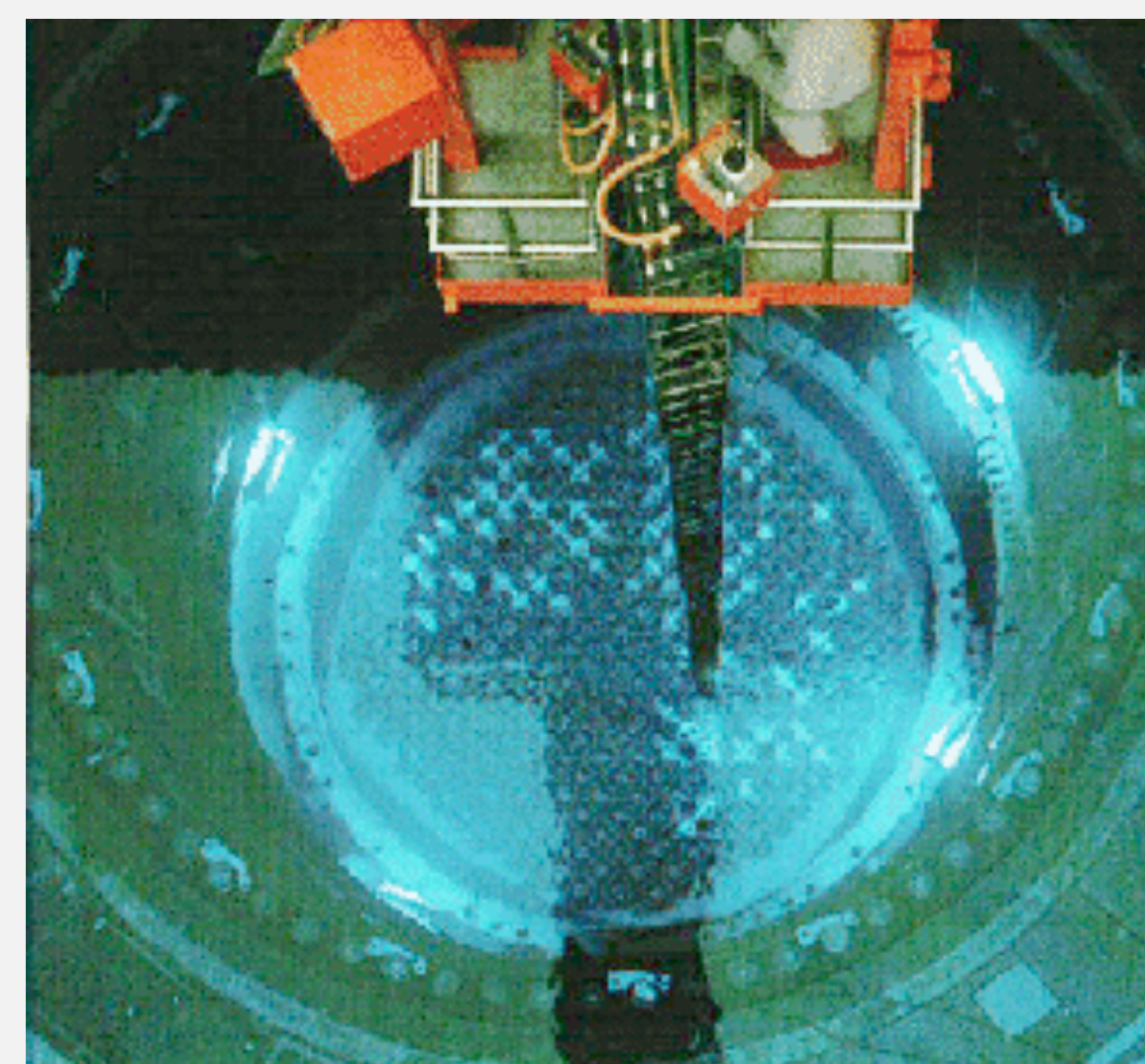
Once the fuel is used up, it needs to be replaced. The fuel in the center had most of its U-235 burned, so it get removed. But on the outside, we starting with highly enriched U-235, and it didn't all get burned up, so the outside fuel gets moved to the middle, and new fuel is added to the outside.

What does spent nuclear fuel actually look like?

It has the same shape as when it was put in: long rods of uranium. It glows blue after the U-235 has burned up, leaving behind radioactive materials. When the radiation travels in water, it glows blue. But don't worry, it's safe underwater because the water acts as a shield for the radiation!



How a nuclear core looks on paper



How it looks in real life

How to play the game

The LED glow sticks turn on and off. If it is off, it is “fresh” fuel, and if it is on it is “spent” fuel.

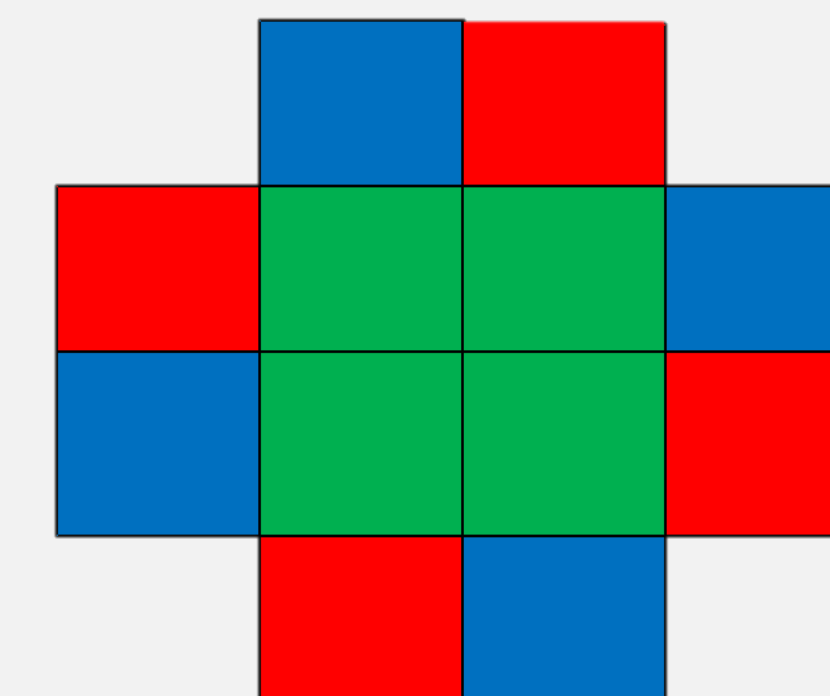
Several colors are provided. The colors can be used to portray several enrichment zones to play the loading pattern game. They can also be ignored if the game is just a refueling race.



With one demo:

Option 1) Time yourself! How fast can you remove the spent fuel and replace it with fresh fuel without dropping any?

Option 2) Use the colors to simulate a loading pattern, and refuel the core to match a loading pattern card!



Loading card

With two demos:

Race against each other! Who can remove the spent fuel and replace it with fresh fuel the fastest? Remember, if you drop one of the fuel rods, it's game over!

Materials needed:

- Reactor core with grid inside
- 12-20 LED reusable glow sticks
- Test tube rack
- Grabber arm
- Timer
- Loading pattern cards



