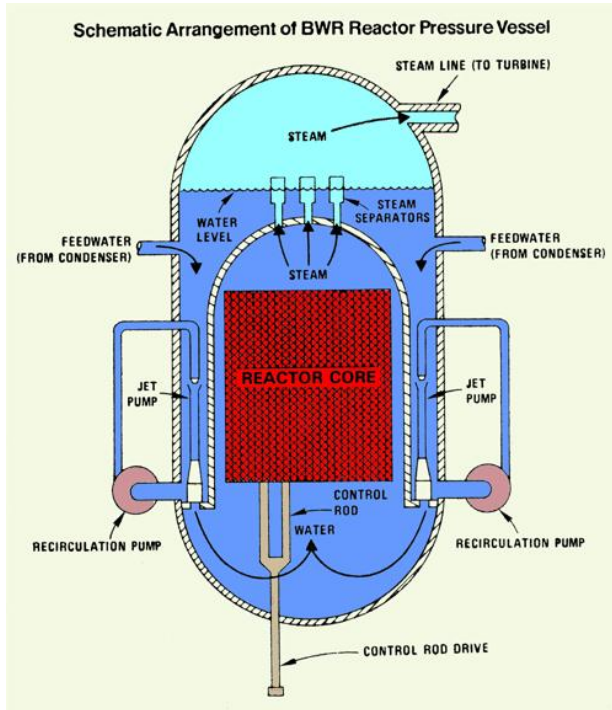




MANUAL REACTOR TRIP AT FERMII TWO

The operators at Fermi Unit 2 in Michigan manually scrammed the reactor on January 31, 2008, after both recirculation pumps tripped. The reactor had been operating at 100 percent power. Fermi Unit 2 has a boiling water reactor (BWR). In this type of reactor, water flowing upward through the fuel bundles comprising the reactor core is boiled by the energy released by the splitting atoms. The steam leaves the reactor vessel via four steam lines (pipes) to the turbine where it is used to make electricity.

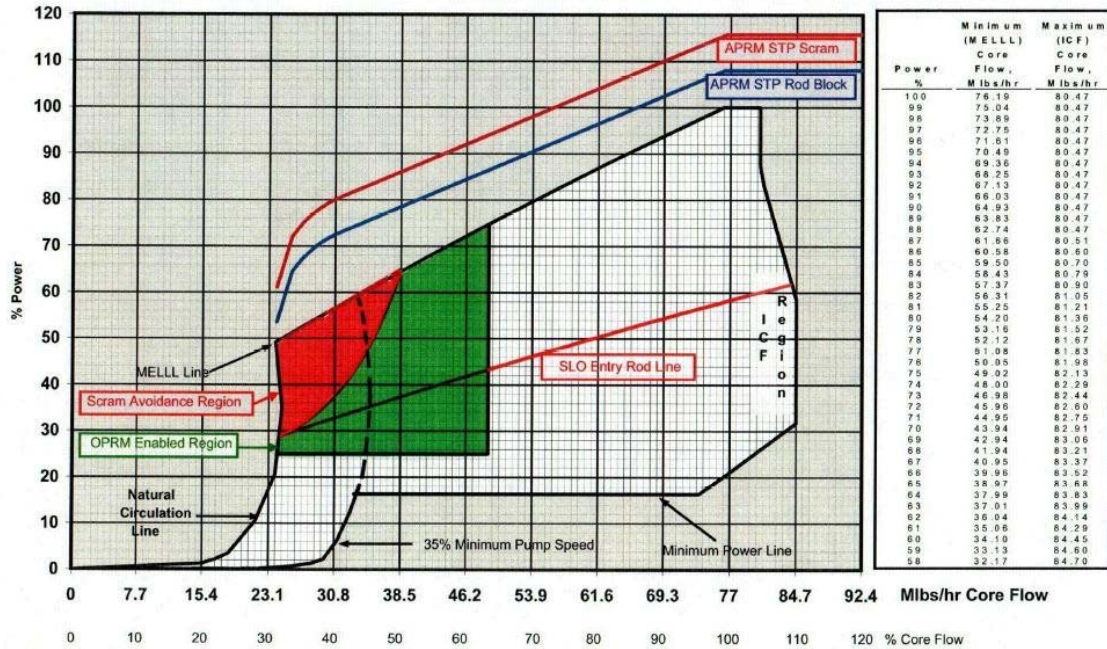


To maintain a constant water level inside the reactor vessel, that amount of steam is matched by an equal amount of feedwater entering the reactor vessel. Each of the two recirculation pumps draws water from inside the reactor vessel and returns it to the reactor vessel via components called jet pumps. The jet pumps function like the underwater nozzles in a hot tub; the high velocity water exiting the jet pumps causes the rest of the water to move, too. The amount of recirculation flow through the jet pumps can be used to control the power level of the reactor core. When the flow rate increases, the reactor power level increases. Conversely, the reactor power level drops when the flow rate decreases.

When both recirculation pumps tripped at Fermi Unit 2, there was no longer forced flow through the jet pumps; like turning off the underwater nozzles in a hot tub. The only flow through the reactor core resulted from natural circulation – the steam bubbles created within the reactor core region floated upwards and the feedwater entering the reactor vessel moved to fill in that vacated space.

The loss of forced flow through the jet pumps resulted in a significant reduction in the flow rate through the reactor core, which in turn caused a significant reduction in the power level of the reactor core. The reduction in reactor core power level meant that the amount of steam being produced and leaving the reactor vessel also decreased. An automatic control system sensed the steam flow reduction and caused a corresponding reduction in the flow of feedwater entering the reactor vessel, thus maintaining the vessel water level constant. So, why did the operators scram Fermi Unit 2?

The answer is explained using a chart called the power/flow operating map for BWRs like Fermi Unit 2. It shows the operating regime allowed for reactor core flow and reactor power level combinations. Fermi Unit 2 had been operating at close to 100 percent reactor core flow and 100 percent reactor power. When both recirculation pumps tripped, the reduction in reactor core flow caused the reactor power level to drop back along the solid black line in the graphic until the left endpoint defined by natural circulation was reached. This endpoint put Fermi Unit 2 at approximately 30 percent reactor core flow and 50 percent reactor power. More significantly, it put the unit solidly within the red zone; an area where reactor operation is not allowed. The operators at Fermi immediately and properly scrammed the reactor to exit the red zone.



Operating in the red zone is forbidden because BWRs can be unstable there. For example, LaSalle Unit 2 had both recirculation pumps trip at 100 percent reactor power on March 9, 1988. Like at Fermi Unit, LaSalle Unit 2 dropped back to about 50 percent power. But about five minutes later, the unit experienced power swings that increased in size. As the plot from that incident shows, the reactor power level 6 ½ minutes after the pumps tripped swung from 90 percent (0.9) to 30 percent (0.3) in about three seconds. The LaSalle operators watched as the power swings triggered an automatic reactor scram when one of the up swings reached 120 percent power. After the LaSalle incident, NRC required BWRs to refrain from intentionally entering and not be restrained from immediately exiting the red zone.

