HW4

Monday, September 22, 2025 9:56 AM

1. The Three Mile Islan (TMI) accident began when the main feed water pumps failed, the flow rate dropped from around 9000 klb/h to 0. This tripped the reactor which immediately drops the power from around 100% to about 5%, which is from the decay heat of the system.

   The fuel max temperature remains at around 600F even after dropping from 950F. The auxiliary feed water valves were being worked on before the main feedwater flow failed, which meant that the feedwater couldn't be replaced by the auxiliary system. This lack of feedwater to the steam generators led to the primary coolant temperature beginning to rise. The temperature rise was complemented by a rise in pressure in the primary coolant loop. To release the pressure, a valve at the top of the pressurizer was opened, to prevent the system from going water solid. Though this did release the pressurizer pressure, the valve stayed open, even though the operators didn't know. This led to continued decrease in the pressurize pressure.

   The decrease in the pressurize pressure meant that the high pressure injection system turned on, ensuring that there was coolant flow in the primary loop. The sensor in the pressurizer read that it was still full of coolant which led the operators to believe that the entire system was full of coolant. Since this would mean that there wasn't a need for extra coolant, the reactor operators turned the high pressure injection system off. This meant that the coolant continued to leak out of the primary coolant loop, there wasn't any coolant surrounding the core leading fuel temperature to remain constant instead of decreasing and there was a continued increase in the pressure in the containment building.

2. 5 different reactor trips
   a. The reactor tripped in this scenario due to some electrical failure, which leads to the main feed water system failing and an immediate decrease in the primary coolant flow. The immediate effect is that the reactor trips and returns to decay heat levels. The safety injection flow has remained at 0 throughout the transient as there is no power to drive the High Pressure Injection System. The auxiliary feedwater system seems to be driven by a turbine as despite there not being any power, the flow is established to continue the removal of heat from the system. The immediate drop in the pressure and pressurizer level also signal the loss of power, but the diesel generators kick back on re-establishing the higher pressure and pressurizer level. The reactor operators need to focus on ensuring the power comes back on line, and there is continuous coolant in the primary loop as this will ensure safe operation of the plant.
   b. In this scenario, the loss of pressure in the pressurize leads to a continuous vent to containment which leads to the pressure in the building increasing a lot. This loss of pressure is met by the initiation of the safety injection flow to maintain pressure coolant flow - the flow graph shows it struggling to return to an equilibrium, before slowly reducing in flow. This is because there is a loss of coolant, as is clear in the pressurizer level reaching 0.0. The reactor tripped which also leads to the main feedwater flow reducing but the auxiliary flow doesn't require power so it matches the loss in flow. To maintain safety the reactor operators have to ensure that the core continues to have coolant on it as there will be a lot of decay heat that needs to be removed continuously
   c. This scenario involves the insertion of control rods, the reactor responds to each insertion as the reactor power falls very quickly, before the control rod is removed from the reactor. This causes the power and fuel temperature to both climb before the rods seem to be inserted again which leads to a continuously decreasing cycle of power. The overall change in power is very small as is the change in the pressurizer level and the pressure. The fuel temperature

oscillates with the reactor power, and the auxiliary feed and safety injection flow both are not activated. The pulsing of the reactor could cause problems, but does not seem to be operating outside of usual bounds for the reactor and could just be the shutdown process - the operators just need to proceed with caution or stop playing with the control rods if that's what the problem is

d. The immediate failure of the RCP leads to the reactor tripping and an immediate decrease in the pressure and the pressurizer level. Since the containment pressure doesn't change, there is no rupture or loss in coolant. The flow in the secondary loop continues to be maintained by the auxiliary system. It is clear that the failure of this primary pump was the problem because the flow immediately drops to 0, however the fuel temperature continues decreasing which signifies that there is a spray or other system ensuring that heat is still being removed from the system. The use of accumulators, at the lowest point in the pressure graph, ensures that coolant remains on the core, and the use of core sprays could help ensure that the temperature stays low.

e. In this scenario, there is station blackout, as the main feedwater flow pumps fail. Around the same time there is also a loss of coolant accident, as the primary coolant flow fails, and there is a steady rise in the containment pressure. Though the safety injection systems would have activated, there is no power to help ensure that they operate so there is no flow of external coolant. The lack of pressure and pressurizer level also signifies that there is a loss in coolant. As a reactor operator, the most important task would be to ensure that the diesel generators get online so that the safety injection system can get back online to replace the coolant being lost from the rupture in the primary loop. The auxiliary feedwater flow is driven by the turbine so it continues to remove heat from the primary loop while there is enough heat but it will remain dangerous for a longer time which requires extra coolant.