Homework #10

Web Problem #10
Nuclear Reactor Design and Analysis

1. A decay-heat cooling system is capable of removing 1 kW from the surface of a typical PWR fuel rod (use PWR specification tables listed in earlier lectures). Assume the rod has operated for an essentially infinite period before shutdown.
    a. At what time will the decay energy generation rate be matched by the cooling capability?
    b. What is the maximum amount of decay-heat energy that will be stored in the rod following shutdown?

2. For the plant described in the table below, a primary system LOCA occurs, which results in the final equilibrium state indicated in the table, with a peak containment pressure from the primary system blowdown of 0.523 MPa. Assume that the primary system failure analyzed in that accident sends an acoustic wave through the primary system that causes a massive failure of steam generator tubes. Although main and auxiliary feedwater to all steam generators are shut off promptly, the entire secondary system inventory of 89 m3 at 6.89 MPa is now released to containment by blowdown through the primary system. Assume for this case that the secondary system inventory is all at saturated-liquid conditions. What is the new containment pressure? (assume no decay heat)

Fluid	Heat addition during blowdown (Joules)	Volume (m^3)	Pressure (MPa)	Temperature (°K)	Quality (x_s) or relative humidity (ϕ)
Example 7-1: saturated water mixture in equilibrium with air as final state					
Primary coolant water (initial)		$V_p = 354$	15.5	617.9	Assumed saturated liquid
Containment vessel air (initial)		$V_c = 50{,}970$	0.101	300.0	$\phi = 80\%$
Mixture (final)	$Q = 0$	$V_T = 51{,}324$	0.523	415.6	$x_{st} = 50.5\%$
Example 7-2: superheated steam in equilibrium with air as final state					
Secondary coolant water (initial)		$V_s = 89$	6.89	558	Assumed saturated liquid
Containment vessel air (initial)		$V_c = 50{,}970$	0.101	300	$\phi = 80\%$
Mixture (final)	$Q = 10^{11}$	$V_T = 51{,}059$	0.446 (64.7 psia)	478	$\phi = 17\%$

3. **TEAM PROBLM:** Develop an exhaustive (or as much as you can manage here) list of LBE for your MSR concept. Include events for each system in your plant. This list will be used to develop your safety case, so please be complete and take serious thoughts about your events.