(20.1) The gas space (volume 6000 m^3) in the PS system of a large BWR is filled with N_2 at 97 kPa and 25°C. Assume the same temperature in the dry and wet wells and that the heat of evaporation of water and its heat capacitivity are ~2.26 MJ/kg and ~4.18 kJ/kg°C, respectively, up to ~100°C. The 2000 m^3 water in the condensation pool is at 25°C. The primary system contains steam at 287°C and 7 MPa (energy content ~2.8 MJ/kg steam). How many kg of such steam could be dumped into the condensation pool before the pressure in the PS system exceeds 0.1 MPa?

$C_{pool} := 4.18 \cdot 10^3 \cdot joule \cdot kg^{-1} \cdot K^{-1}$

$\rho_{water} := 1 \cdot gm \cdot cm^{-3}$

$V_{pool} := 2000 \cdot m^3$

$C_{steam} := 2.26 \cdot 10^6 \cdot joule \cdot kg^{-1}$

$T_{0pool} := (25 + 273) \cdot K$

$m_{0pool} := V_{pool} \cdot \rho_{water}$

From expansion of N_2(ideal gas law):

$$T_{max} := T_{0pool} \cdot \frac{0.1}{0.097}$$

A first approximation is to regard the mass of pool water as constant:

$$m_{steam} := \left(T_{max} - T_{0pool}\right) \cdot C_{pool} \cdot \frac{m_{0pool}}{C_{steam}} \qquad m_{steam} = 3.409 \cdot 10^4 \cdot \mathrm{kg}$$

$$\Delta m := \frac{m_{steam}}{m_{0pool}} \qquad \Delta m = 1.705 \cdot \% \qquad \left(\frac{\Delta m}{2} + 1\right) \cdot m_{0pool} = 2.017 \cdot 10^6 \cdot \mathrm{kg}$$

Second approximation (starting with the value estimated above):

$m_{0pool} := 2.017 \cdot 10^6 \cdot kg$

$$m_{steam} := \left(T_{max} - T_{0pool}\right) \cdot C_{pool} \cdot \frac{m_{0pool}}{C_{steam}} \qquad m_{steam} = 3.438 \cdot 10^4 \cdot \mathrm{kg}$$

$$\Delta m := \frac{m_{steam}}{m_{0pool}} \qquad \Delta m = 1.705 \cdot \% \qquad \left(\frac{\Delta m}{2} + 1\right) \cdot m_{0pool} = 2.034 \cdot 10^6 \cdot \mathrm{kg}$$

Answer: about $3.4 \cdot 10^4$ kg = 34 ton