33.23 A 75% efficient pump driven by a 95% efficient motor transfers $2000gpm$ of a fluid with a specific gravity of 1.15 from a pressurized storage tank held at $10psig$ to an open reservoir at an elvation $100ft$ higher. Friction losses amout to $15psi$. What is the electrical demand?

A. $58KW$

B. $67KW$

C. $77KW$

D. $89KW$

Write the modified Bernoulli Equation to determine the head added by the pump.

$$h_A = \frac{P_2 - P_1}{\gamma} + \frac{v_2^2 - v_1^2}{2g} + z_2 - z_1 + h_f$$

Since the source and the destination are both holding tanks, assume the velocity term is equal to zero.

$$h_A = \frac{P_2 - P_1}{\gamma} + z_2 - z_1 + h_f$$

The difference in elevation is given in ft as expected. However, the tank pressure and losses are both given in psi, so they should be combined and then converted to ft before using the brake horsepower formula. Normally, if the problem was dealing with water, converting from psi to ft would involve simply multiplying by a factor of 2.31, but in this case the height of a column of a fluid with specific gravity 1.15 would be slightly *less* than for a column of water, so it is necessary to also divide by the specific gravity. Note, the brake horsepower formula involves multiplying by specific gravity, so dividing by SG in this step appropriately washes out of the calculation. Ultimately, the units must align, as it is not valid to add ft to psi directly.

$$h_A = (0psi - 10psi) + (100ft - 0ft) + 15psi$$

$$h_A = 100ft + 5psi$$

$$h_A = 100ft + \frac{(5psi)\left(2.31\frac{ft}{psi}\right)}{1.15} = 110ft$$

Calculate the Brake HP.

$$bhp = \frac{Q\Delta hSG}{3960\eta_{pump}}$$

$$bhp = \frac{(2000)(110)(1.15)}{(3960)(0.75)} = 85.2hp$$

Notice the brake horsepower accounts for the pump efficiency. To determine the electrical demand, it is necessary to also account for the motor efficiency, and convert units to KW.

$$\dot{W} = \frac{85.2hp}{0.95}\left(0.7457\frac{KW}{hp}\right) = 66.9KW$$

Answer B