36.38 A $75KVA$ transformer with 99% efficiency is located in an electrical room at $70°F$. The transformer's enclosure is a floor standing box with dimensions of $3ft$ height, $2ft$ width, $3ft$ depth. The exposed surfaces have an average temperature of $85°F$. The load is resistive and uses 60% of the transformer's capacity. What is the overall heat transfer coefficient?

A. $1.9\frac{Btu}{hr \cdot ft^2 \cdot °F}$

B. $2.4\frac{Btu}{hr \cdot ft^2 \cdot °F}$

C. $2.8\frac{Btu}{hr \cdot ft^2 \cdot °F}$

D. $4.7\frac{Btu}{hr \cdot ft^2 \cdot °F}$

The Overall Heat Transfer Coefficient is given by:

$$\dot{Q} = UA\Delta T \rightarrow U = \frac{\dot{Q}}{A\Delta T}$$

The surface area for the floor standing enclosure includes 5 faces: the top and 4 sides. Note there is no base area to include in the surface area.

$$A = (2)\left[(3ft)(3ft)\right] + (3)\left[(2ft)(3ft)\right] = 36ft^2$$

The temperature differential is the difference between the exposed surfaces of the enclosure and the ambient temperature in the electrical room.

$$\Delta T = 85°F - 70°F = 15°F$$

The heat produced by the transformer depends on the demand, efficiency, and power factor. The load is purely resistive; therefore the power factor should be taken as unity.

$$PF = \frac{KW}{KVA} = 1$$

The *real* power draw i.e. the heat load in KW is then:

$$P = (75KVA)(.6)\left(\frac{1KW}{1KVA}\right) = 45KW$$

Calculate the losses associated with a 99% efficient transformer, converted to Btu:

$$\dot{Q} = (45KW)(0.01)\left(3412\frac{Btu}{hr \cdot KW}\right) = 1535\frac{Btu}{hr}$$

Calculate U:

$$U = \frac{\dot{Q}}{A\Delta T} = \frac{\left(1535\frac{Btu}{hr}\right)}{(36ft^2)(15°F)} = 2.84\frac{Btu}{hr \cdot ft^2 \cdot °F}$$

Answer C