## Why STEP® (Self-regulating Technology of Electro Plastics) is More Efficient

**Heat Loss Calculation Program**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HDD | is heating degree days in °F | | | 6164 | | | |
| Δt | is °F indoor - °F outdoor | | | 32 °F | | | |
| | | | | Central | Water Tubing | Electric Cable | STEP Warmfloor |
| η | Efficiency | Gas furnace | 0.80 | 0.80 | 0.90 | 1.00 | 1.00 |
| | | Gas boiler | 0.90 | | | | |
| | | Electric | 1.00 | | | | |
| | | | | | 2.08 / 2.5 = | 2.5 / 2.5 = | 1 / 2.5 = |
| | **f1** | Heat distribution factor | | | 0.832 | 1 | 0.4 |
| | **f2** | Self-regulating factor | | | | | 0.84 |

### Heat distribution factor

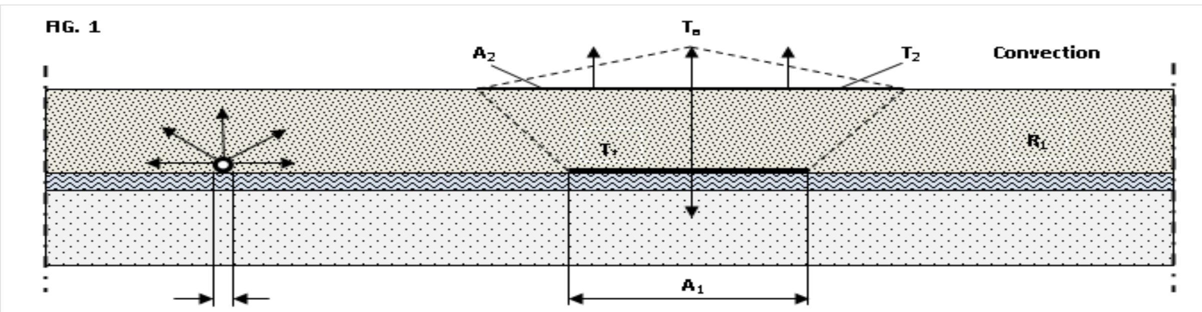


Fig. 1 shows a cross sectional area of a floor with a cable or tubing and STEP Warmfloor® flat element.

Consider typical values for heating a square foot with $R_1 = 2 \cdot \mathrm{h\,ft^2\,°F \cdot Btu^{-1}}$, $T_2 = 75\ °\mathrm{F}$ and $T_a = 70\ °\mathrm{F}$.

According to Newton's law, the rate of heat transfer to the surrounding air is proportional to the floor exposed area (A) and to the difference between the floor temperature and the air temperature. For the conservation of energy, the heat transfer for conduction equals the heat for convection, and in a simplified equation:

$$Q \propto A_1 \cdot R_1(T_2 - T_1) = A_2 \cdot k(T_a - T_2)$$

| **STEP® Flat Element**<br>**Width = 1 ft**<br>**Length = 1 ft** | **Electric Cable**<br>**Diameter = 0.07 in**<br>**Length = 4 ft (double-wire, 3 inches spacing)** | **Water Tubing**<br>**Diameter = 0.5 in**<br>**Length = 2 ft (6 inches spacing)** |
|---|---|---|
| $A_1 = 1\ \mathrm{ft} \cdot 1\ \mathrm{ft} = 1\ \mathrm{ft^2}$<br>$T_1 = 80\ °\mathrm{F}$ | $A_1 = 4\ \mathrm{ft} \cdot 0.0058\ \mathrm{ft} = 0.023\ \mathrm{ft^2}$<br>$T_1 = 160\ °\mathrm{F}$ | $A_1 = 2\ \mathrm{ft} \cdot 0.0416\ \mathrm{ft} = 0.083\ \mathrm{ft^2}$<br>$T_1 = 104\ °\mathrm{F}$ (water temperature) |
| $1\ \mathrm{ft^2} \cdot 2 \cdot \mathrm{h\,ft^2\,°F \cdot Btu^{-1}}$<br>$(75\ °\mathrm{F} - 80\ °\mathrm{F})$<br>$= A_2 \cdot k(70\ °\mathrm{F} - 75\ °\mathrm{F})$<br>$\therefore \boldsymbol{A_2 \cdot k = 2\ \mathrm{ft^2}}$ | $0.023\ \mathrm{ft^2} \cdot 2 \cdot \mathrm{h\,ft^2\,°F}$<br>$\cdot\ \mathrm{Btu^{-1}}(75°\mathrm{F} - 160\ °\mathrm{F})$<br>$= A_2 \cdot k(70\ °\mathrm{F} - 75\ °\mathrm{F})$<br>$\therefore \boldsymbol{A_2 \cdot k = 0.78\ \mathrm{ft^2}}$ | $0.083\ \mathrm{ft^2} \cdot 2 \cdot \mathrm{h\,ft^2\,°F}$<br>$\cdot\ \mathrm{Btu^{-1}}(75\ °\mathrm{F} - 104\ °\mathrm{F})$<br>$= A_2 \cdot k(70\ °\mathrm{F} - 75\ °\mathrm{F})$<br>$\therefore \boldsymbol{A_2 \cdot k = 0.96\ \mathrm{ft^2}}$ |

**Note:** Since $k$ is constant, we may assume $k = 1\ \mathrm{Btu\ h \cdot °F^{-1} \cdot ft^{-2}}$, leaving the above values of $A_2$ to be 2 $\mathrm{ft^2}$, 0.788 $\mathrm{ft^2}$ and 0.96 $\mathrm{ft^2}$ respectively.

A typical total heating installation with the **STEP®** system requires: **4.5 W/ft²**

To give the same heat output, an **Electric Cable** system would require:
2 ft² / 0.78 ft² = 2.5 times more wattage; which would be 4.5 W/ft² x 2.5 = **11.25 W/ft²**

While a **Water Tubing** system would require:
2 ft² / 0.96 ft² = 2.08 times more wattage; which would be 4.5 W/ft² x 2.08 = **9.36 W/ft²**