Technical Information

Three Phase Equations & Heater Wiring Diagrams

**Open Delta & Wye**

Three phase heating circuits are most efficient when operated under balanced conditions. If it is necessary to operate an unbalanced load, the equations below can be used to calculate the circuit values for open three phase Delta or Wye circuits. The terms used in the equations are identified below:

- \( V_L \) = Line Voltage
- \( V_P \) = Phase (Element) Voltage
- \( I_L \) = Line Current (Amps)
- \( I_P \) = Phase Current (Amps)
- \( W_T \) = Total Watts
- \( R_e \) = Element Resistance
- \( R_C \) = Circuit Resistance in Ohms measured from Phase to Phase

### 3Ø Open Delta

![Diagram of 3Ø Open Delta](image)

\[
\begin{align*}
V_L &= V_P \\
W_T &= 2V_L \times I_L \\
I_P &= I_L \\
R_C &= V_L^2 + W_T
\end{align*}
\]

The loss of a phase or failure of an element in a three (3) element Delta circuit will reduce the wattage output by 33%.

### 3Ø Open Wye

![Diagram of 3Ø Open Wye](image)

\[
\begin{align*}
V_L &= V_L \\
W_T &= I_L \times V_L \\
I_P &= I_L \\
R_C &= V_L^2 + W_T
\end{align*}
\]

The loss of a phase or failure of an element in a three (3) element Wye circuit will reduce the wattage output by 50%. Heating elements are basically in series on single phase power.

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**Typical Heater Wiring Diagrams**

The following diagrams show typical heater wiring schematics.

### Single Phase 120 VAC heater circuit where line voltage and current do not exceed thermostat rating.

![Diagram of Single Phase 120 VAC heater circuit](image)

### Single Phase AC circuits where line voltage and current do not exceed thermostat rating.

![Diagram of Single Phase AC heater circuit](image)

### Three Phase AC heater circuit where line voltage and current do not exceed thermostat rating.

![Diagram of Three Phase AC heater circuit](image)

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**Wiring & Ambient Temperatures**

Ambient temperatures must be considered when selecting wiring materials for electric heater circuits. Heating equipment and processes may cause associated wiring to operate well above ambient temperatures. These temperatures may result from heat conducted from the heater terminals, radiation from heated surfaces or simply high ambient air temperatures. Nickel plated copper or nickel alloy conductors with high temperature insulation should always be used in high temperature areas. Outside these areas, conventional wiring materials can usually be used. 60°C building wire is usually not suitable unless otherwise indicated.

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**Wiring in Severe Conditions**

Moist or wet locations require gasketed terminal and junction boxes to protect equipment and wiring. Rigid conduit is recommended. Hazardous Locations require the use of approved explosion-proof terminal and junction boxes. Rigid conduit or mineral insulated (MI) cable is mandatory in Division 1 areas. Some Hazardous Locations may require conduit seals (EYS) adjacent to the equipment.