

### Recommendations for Improving the Life of Tempco Hi-Density Metric Cartridge Heaters

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#### Determining Fit

When heating a platen, mold, die or hot runner probe with Hi-Density Metric Cartridge Heaters inserted into drilled holes, fit is an important factor in determining the life expectancy of the heater. Fit is the difference between the minimum diameter of the cartridge heater and the maximum diameter of the hole. Unheated sections on a Hi-Density cartridge may be smaller in diameter due to swaging. To determine fit, use the smallest diameter on the heated length only.

**Example:** A 10 mm nominal OD Hi-Density cartridge heater has an actual diameter of  $9.95 \pm 0.03$  mm, which translates to a minimum diameter of 9.92 mm. If used in a  $10.01 \text{ mm} \pm 0.02$  mm hole, the fit would be .11 mm ( $10.03 \text{ mm} - 9.92 \text{ mm} = 0.11 \text{ mm}$ ).

When medium watt density heaters (less than 9.30 watts per square centimeter) are used in low temperature applications (less than 600°F [315°C]) general purpose drills are commonly used to drill holes. The typical hole size may be 0.07 mm to 0.20 mm over the drill size. For higher watt density and/or higher temperature applications, we recommend that the holes are drilled and reamed for the tightest possible fit. In applications where precise temperature control and heat transfer properties are required, Hi-Density cartridge heaters can be centerless ground to  $\pm 0.01$  mm.

Although a tighter fit is desirable to efficiently transfer heat and to get long heater life, a looser fit will aid in installing and removing heaters, especially long heaters. We recommend that you apply Tempco's BNS anti-seize cartridge heater coating as it will improve heat transfer and will make the removal of heaters easier.

The graph in Fig 1. (page 2-29) shows the effect of fit in determining the maximum recommended watt density on a steel platen. As it is indicated in the graph, the tighter the fit, the higher the maximum recommended watt density.

#### Temperature Control and Location of Temperature Sensing Device

In order to better control the heater temperature and hence the resistance wire temperature, use of an appropriate temperature control and the proximity of the heater to the sensor is very important. The graph in Fig 1. (page 2-29) shows the effect of operating temperature in determining the maximum recommended watt density on a steel platen where the sensor is located 12.5 mm from the heater. Higher watt density heaters can generate heat faster than the surrounding area's ability to dissipate heat. This creates a thermal lag between the heater and the sensor. The closer the sensor to the heater, the better you can control the heater temperature. By keeping the sensor further from the heater, temperature gradients of several hundred degrees can be observed in many applications, especially during initial start-up and heavy thermal cycling. Although the set operating temperature may be low, the heater may be running at a very high temperature. This is a common cause of heater failure. This can be minimized using time proportional and PID functions of the temperature controllers. See Section 13 for temperature controllers and Section 14 for thermocouples and sensors.

#### Power Control

Power control methods affect the life expectancy of heating elements. In general, although economical, on-off controls increase thermal fatigue and oxidation rate on heating elements by causing wide temperature swings of the internal heating element. Silicon Controlled Rectifiers (SCRs), Mercury Relays and Solid State Power Controls can increase the life expectancy of heating elements by reducing the temperature swings of the internal heating element. See Section 13 for power controls.

### Important Installation Considerations

1. For closest fit and best heat transfer, use reamed holes.
2. When possible, drill holes through the object being heated. This will make heater removal easier.
3. When using an anti-seize coating like Tempco's BNS spray or paste, **do not apply** over lead wires or any other current carrying conductors.
4. When using insulated tape or sleeving, check to make sure it is rated for the temperature of the application. Lower temperature rated materials can contain an adhesive or binder that can carbonize and become electrically conductive.
5. When using heaters near their maximum recommended watt density, it is recommended that the temperature sensing probes be located approximately 12.5 mm from the heater sheath.
6. Lead wires should not be located in the hole containing the cartridge heater during operation. This may cause the lead wires to be exposed to temperatures above their rated temperature.
7. When used in a vacuum application, make sure the lead end of the heater is outside the vacuum. If the lead has to be in the vacuum, consult Tempco for specific recommendations.
8. Many applications will subject a heater's electrical terminations to one or more of the following potentially damaging conditions:
  - Moisture
  - Flexing
  - Oil and other contaminants
  - Abrasion
  - High temperature

**Note:** To protect the heater from damage in these harsh environments, Tempco has a wide selection of terminations and options available. See pages 2-39 through 2-60 for details.

#### CALCULATING WATTAGE REQUIREMENTS

**Formulas and related data** to calculate wattage requirements are detailed in the Engineering Section located at the back of this catalog. For new applications it is recommended that testing under actual operating conditions be performed to confirm wattage and watt density calculations.

An excellent evaluation method is to power up a heater with the calculated wattage and watt density through a variable voltage transformer. By changing the voltage and therefore the heater output, thermocouples sensing heater and process temperature can verify the design.