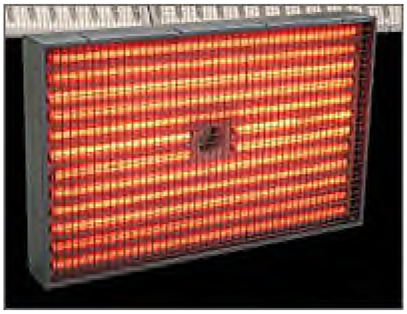
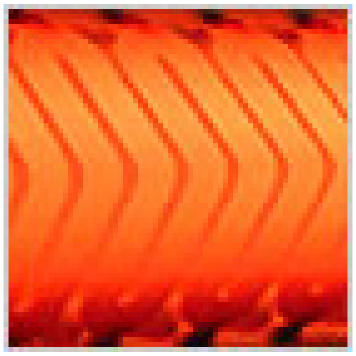
# Infrared Heaters



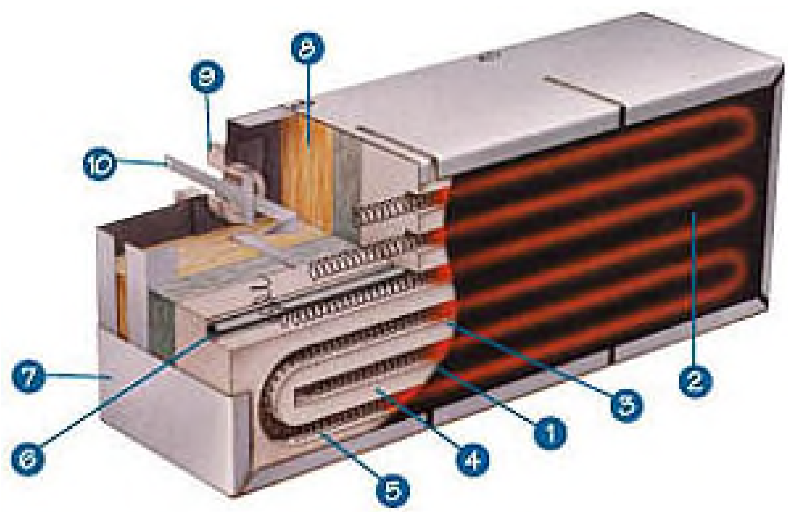


## Fast Response Medium Wavelength Infrared Panel Heaters:

The V-series is perfect for applications that require high power, tight process control, and fast heat-up/ cool-down. V-Shaped stamped elements have low mass for fast heating/ cooling and minimal thermal lag for extremely tight process control. The elements are bonded to a high temperature insulation board having low thermal conductivity, low thermal mass and low heat capacity to minimize stored heat so they can be switched on and off in seconds. This makes them ideal for processing heat sensitive products such as coated webs and textiles. V-series heaters offer power densities and response times that rival those of short wavelength heaters except they come in a very durable construction and have a medium wavelength output which is readily absorbed by most products. Therefore, they are ideally suited for drying water or solvents as well as heating plastics, glass, etc.

## Features

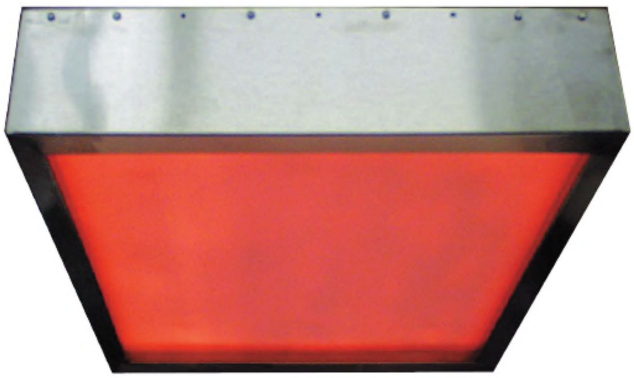
1. High-temperature quartz cloth
2. High-temperature black coating
3. High-temperature cement bond
4. Refractory board to hold resistance wire
5. Precision resistance wire
6. Quartz thermowell tube (optional)
7. Heavy gauge aluminized steel frame
8. Blanket insulation
9. Ceramic bushings to insulate terminals
10. Stainless steel terminals

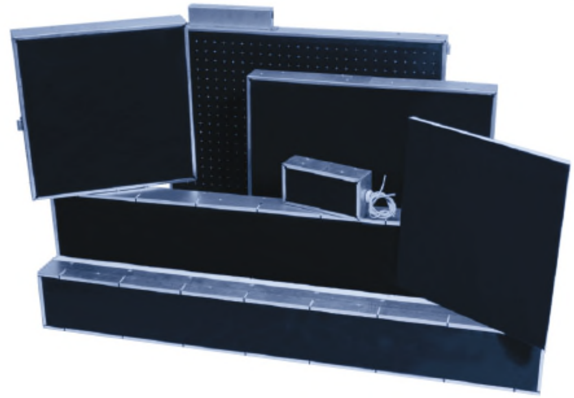


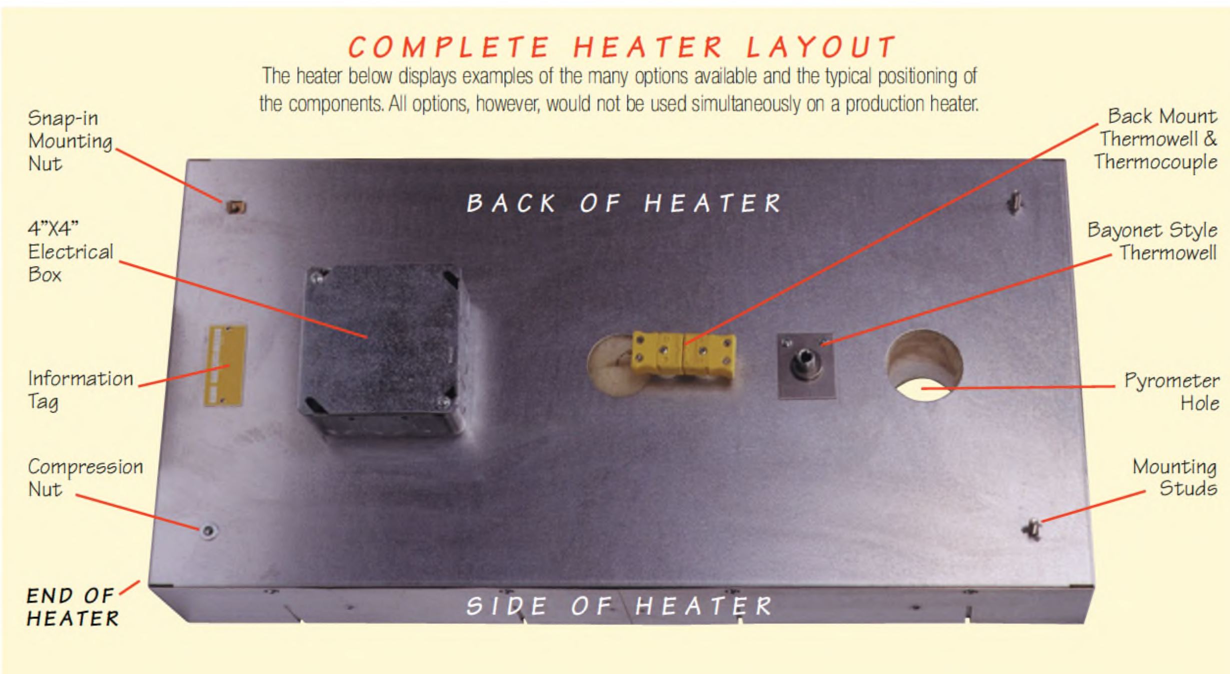

| STANDARD DIMENSIONS | | | | | | |
|---|---|---|---|---|---|---|
| **Width (mm)** | **Length (mm)** | **F Series** | **FBA Series** | **G Series** | **M Series** | **Q Series** |
| 6” (152.4) | 12”(304.8) • 18”(457.4) • 24”(609.6) • 30”(762)• 36” (914.4) | X | X | X | X | |
| 6” (152.4) | 42”(1066.8) • 48” (1219.2) • 54”(1371.6) • 60”(1524) | X | X | | X | |
| 10” (254) | 4” (101.6) • 6” (152.4) • 8” (203.2) • 10” (254) | | | | | X |
| 12” (304.8) | 6” (152.4) • 10” (245) • 12” (304.8) | | | | | X |
| 12” (304.8) | 12”(304.8) • 18” )457.4) • 24”(609.6) • 30”(762) • 36” (914.4) | X | X | X | X | |
| 12” (304.8) | 42” (1066.8) • 48” (1219.2) • 54” (1371.6) • 60” (1524) | X | X | | **42” or 48”** | |
| 12” (304.8) | 72” (1829 ) • 84” (2133.6) | X | **72”Only** | | | |
| 16” (406.4) | 16” (406.4) • 24” (609.6) | X | X | X | X | |
| 18” (457.2) | 18” 457.2) | X | X | X | X | |
| 24” (609.6) | 24” (609.6) | X | X | | | |

Consult Southeast Thermal Systems for custom heaters to meet your specific requirements

# Infrared Heaters

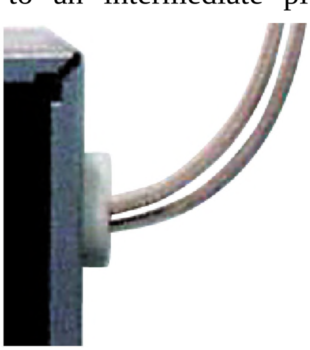







## Wire Leads

The wire leads option is a fourth termination option available on flat panel I/R heaters. This option is only available on heaters with the watt density lower than 10wsi (15.5 kw/m2). A high temperature wire is resistance welded to an intermediate piece of stainless steel which is in turn resistance welded to the heating element. The wire leads can be any required length.



## End Pieces

One last mounting option is the use of some special metal clips or brackets on the ends of the heater in lieu of the studs or nuts. This approach can simplify the heater installation for certain applications.

# Infrared Heaters

**MaxLife FSM Panel Radiators** are ceramic infrared radiators, which are designed for operating temperatures up to 720 °C. Surface ratings of up to 64 kW/m² can be installed. The durability of MaxLife panel radiators FSM has been maximized. They are usable for 35000 hours and more when operated correctly and under normal conditions. Due to this significantly longer service life of MaxLife radiators the cost for heater exchange is reduced. There are much lower costs per operating hour. A guarantee of operation about 20000 hours or 3 years beginning from the manufacturing date exists for radiators of the FSM series on the basis of correct heater use and normal operating conditions. MaxLife panel radiators FSM are available in three designs and cover the power range from 60 W to 1000 W.

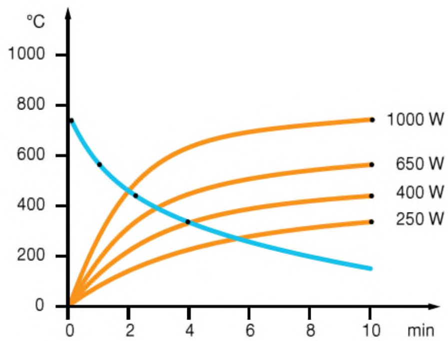



Fig. 3: Radiator temperatures
Heating-up: red curves
Cooling-down: blue curve

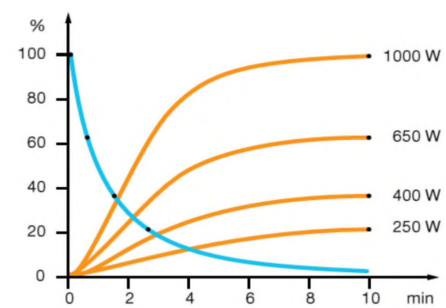
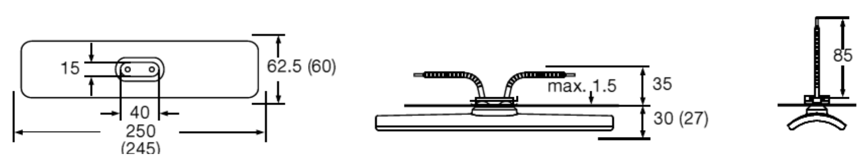
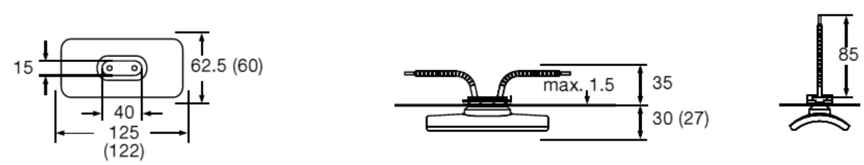



Fig. 4: Radiant powers
Heating-up: red curves
Cooling-down: blue curve

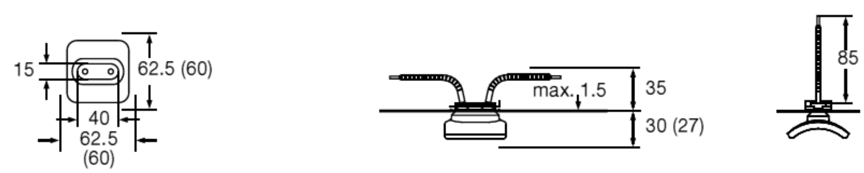
## FSM




## FSM/2




## FSM/4




| | | | | |
|---|---|---|---|---|
| FSM 220g | 250w | 400w | 650w | 1000w |
| FSM/2 125g | 125w | 200w | 325w | 500w |
| FSM/4 75g | 60w | 100w | 200w | 250w |
| Surface Rating | 16.0 kW/m² | 25.6 kW/m² | 41.6 kW/m² | 64.0 kW/m² |
| Typical Op. Temp. | 400°C | 500°C | 620°C | 720°C |
| Max. Permissible Temp. | 750°C | 750°C | 750°C | 750°C |
| Wavelength Range | 2-10µm | 2-10µm | 2-10µm | 2-10µm |

# Infrared Heaters

**SFH Super Flat Radiators** are ceramic infrared radiators in flat design. They reach operating temperatures up to 800°C and surface ratings up to 64 kW/m². The radiators of the SFH series are very suited for applications, which require space-saving installation. The borders of SFH radiators are used as bearing surface on a metal mounting sheet or reflector. For each radiator a corresponding rounded mounting hole is required to place the heaters into them. When mounting SFH super flat radiators a heat insulation can be added additionally. A temperature resistant insulating material like Elstein THI thermal insulation sheet can be applied on site directly on the back of the radiator. SFH super flat radiators are available in four designs and cover the power range from 60 W to 1000 W.

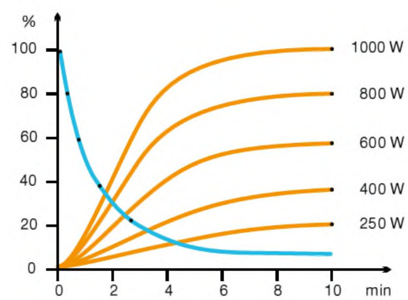



Fig. 3: Radiator temperatures
Heating-up: red curves
Cooling-down: blue curve

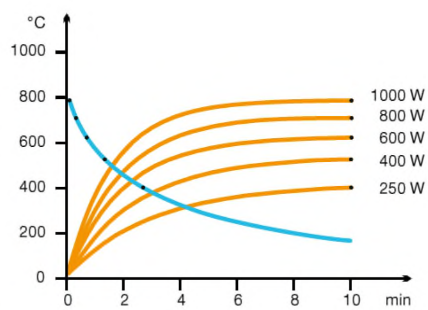
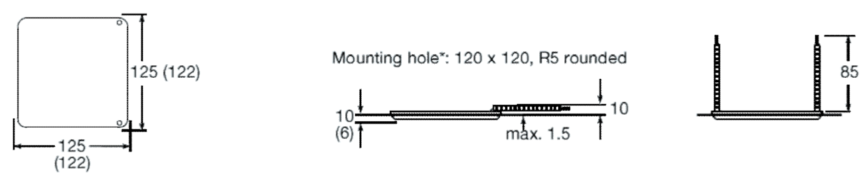
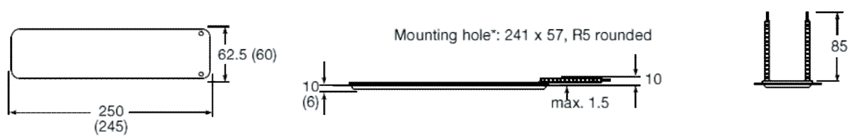



Fig. 4: Radiant powers
Heating-up: red curves
Cooling-down: blue curve

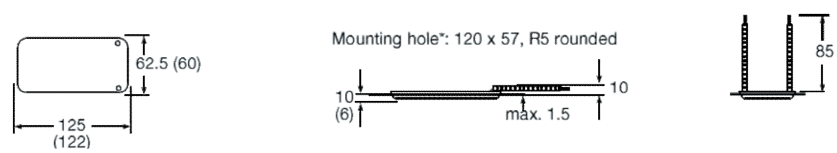
## SFH



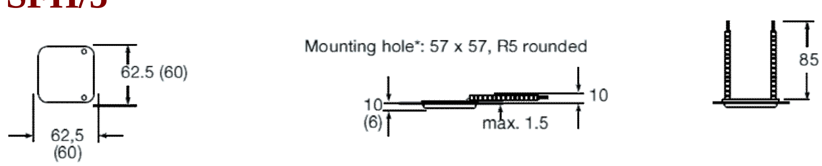

## SFH/1




## SFH/2



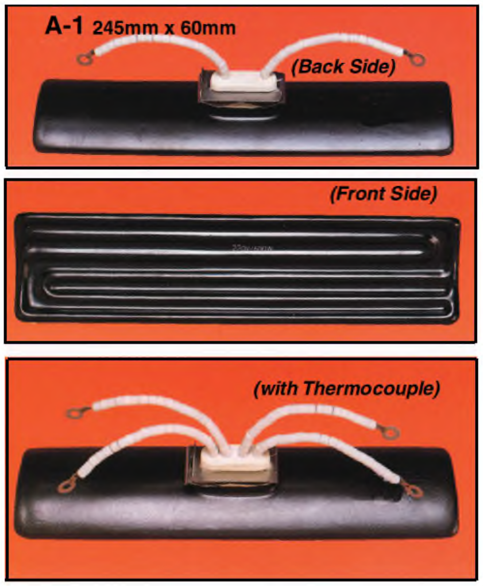

## SFH/5

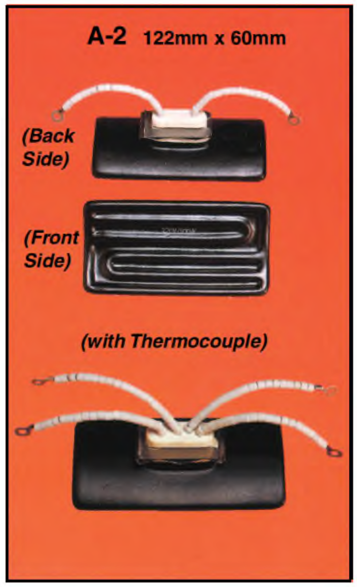


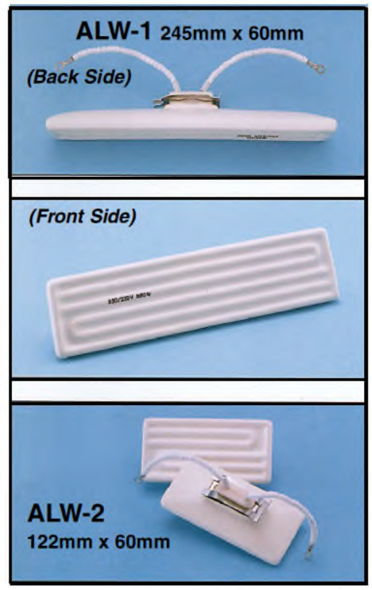

| | | | | | |
|---|---|---|---|---|---|
| SFH/1 SFH 160g | 250w | 400w | 600w | 800w | 1000w |
| SFH/2 85g | 125w | 200w | 300w | 400w | 500w |
| SFH/4 45g | 60w | 100w | 150w | 200w | 250w |
| Surface Rating | 16.0 kW/m² | 25.6 kW/m² | 38.4 kW/m² | 51.2 kW/m² | 64.0 kW/m² |
| Typical Op. Temp. | 440°C | 540°C | 630°C | 720°C | 800°C |
| Max. Permissible Temp. | 900°C | 900°C | 900°C | 900°C | 900°C |
| Wavelength Range | 2-10µm | 2-10µm | 2-10µm | 2-10µm | 2-10µm |

# Infrared Heaters

STS



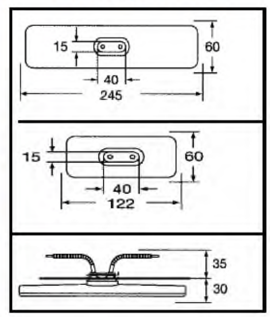



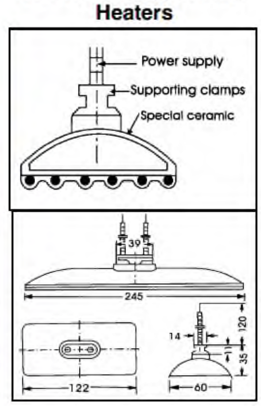

**Parabolic Ceramic Infrared Heaters 4.7" (12 cm) Beaded Leads with Ring Tongue Connectors:**

| *Part Number* | *Size* | *Color* | *Voltage* | *Wattage* | *Surface Temp* |
|---|---|---|---|---|---|
| A-1-1000-B-2 | 245 x 60 mm | Black | 220/230 | 1000 | 780°C |
| A-1-1000-B-4 | 245 x 60 mm | Black | 480 | 1000 | 780°C |
| A-1-650-B-2 | 245 x 60 mm | Black | 220/230 | 650 | 650°C |
| A-1-650-B-4 | 245 x 60 mm | Black | 480 | 650 | 650°C |
| A-1-400-B-2 | 245 x 60 mm | Black | 220/230 | 400 | 500°C |
| A-1-1000-Y-2 | 245 x 60 mm | Yellow | 220/230 | 1000 | 780°C |
| A-1-1000-Y-4 | 245 x 60 mm | Yellow | 480 | 1000 | 780°C |
| A-1-650-Y-2 | 245 x 60 mm | Yellow | 220/230 | 650 | 650°C |
| A-1-650-Y-4 | 245 x 60 mm | Yellow | 480 | 650 | 650°C |
| A-2-500-B-2 | 122 x 60 mm | Black | 220/230 | 500 | 780°C |
| A-2-325-B-2 | 122 x 60 mm | Black | 220/230 | 325 | 650°C |
| A-2-500-Y-2 | 122 x 60 mm | Yellow | 220/230 | 500 | 780°C |
| A-2-325-Y-2 | 122 x 60 mm | Yellow | 220/230 | 325 | 650°C |
| A-1-1000-B-2-K | 245 x 60 mm | Black | 220/230 | 1000 | 780°C |
| A-1-1000-B-4-K | 245 x 60 mm | Black | 480 | 1000 | 780°C |
| A-1-650-B-2-K | 245 x 60 mm | Black | 220/230 | 650 | 650°C |
| A-1-650-B-4-K | 245 x 60 mm | Black | 480 | 650 | 650°C |
| A-1-1000-Y-2-K | 245 x 60 mm | Yellow | 220/230 | 1000 | 780°C |
| A-1-1000-Y-4-K | 245 x 60 mm | Yellow | 480 | 1000 | 780°C |
| A-1-650-Y-2-K | 245 x 60 mm | Yellow | 220/230 | 650 | 650°C |
| A-1-650-Y-4-K | 245 x 60 mm | Yellow | 480 | 650 | 650°C |
| A-2-500-B-2-K | 122 x 60 mm | Black | 220/230 | 500 | 780°C |

**A-1 and A-2 Parabolic Heaters**




**ALW-1, ALW-2 and ITS-H3 Energy Saving Heaters**




**Energy Saving Flat Bottom Hollow Ceramic Infrared Heaters 4.7" (12 cm) Beaded Leads with Ring Tongue Connectors:**

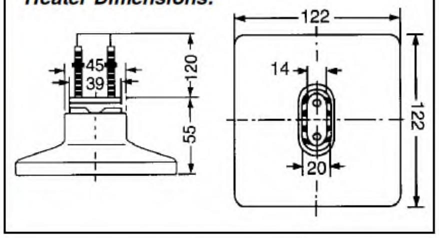
| *Part Number* | *Size* | *Color* | *Voltage* | *Wattage* | *Surface Temp* |
|---|---|---|---|---|---|
| ALW-1-1000-W-2 | 245 x 60 mm | White | 220/230 | 1000 | 750°C |
| ALW-1-1000-W-4 | 245 x 60 mm | White | 480 | 1000 | 750°C |
| ALW-2-500-W-2 | 122 x 60 mm | White | 220/230 | 500 | 750°C |
| ITS-H3-250-W-2 | 60 x 60 mm | White | 220/230 | 250 | 750°C |
| ALW-1-1000-W-2-K | 245 x 60 mm | White | 220/230 | 1000 | 750°C |
| ALW-1-1000-W-4-K | 245 x 60 mm | White | 480 | 1000 | 750°C |
| ALW-2-500-W-2-K | 122 x 60 mm | White | 220/230 | 500 | 750°C |
| ITS-H3-250-W-2-K | 60 x 60 mm | White | 220/230 | 250 | 750°C |

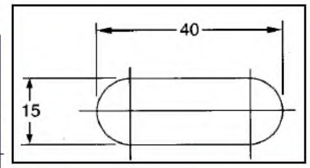
# Infrared Heaters


**Energy Saving Flat Bottom Square (122 x 122 mm) Hollow Ceramic Infrared Heaters 4.7" (12 cm) Beaded Leads with Ring Tongue Connectors:**

| *Part Number* | *Size* | *Color* | *Voltage* | *Wattage* | *Surface Temp* |
|---|---|---|---|---|---|
| EL-2-800-B-2 | 122 x 122 | Black | 220/230 | 800 | 720°C |
| EL-2-650-B-2 | 122 x 122 | Black | 220/230 | 650 | 650°C |
| EL-2-800-B-2-K | 122 x 122 | Black | 220/230 | 800 | 720°C |
| EL-2-650-B-2-K | 122 x 122 | Black | 220/230 | 650 | 650°C |

***Heater Dimensions:***



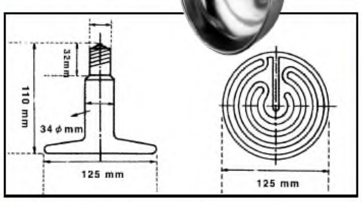

Cutout for:
A-1, A-2, AWL-1, AWL-2, ITS-H3 and EL-2 Heaters

***Reflectors:***

ITS-A-EL

**ITS-2-R-5** Aluminized Steel Reflector 5" Long
**ITS-2-R-10** Aluminized Steel Reflector 10" Long
**ITS-A-EL** Stand-Off Mounting Bracket


**ITS-1-R** Reflector for D-1-500 (6" Diameter)




**Energy Saving Round Bottom 5" Diameter (125 mm) Hollow Ceramic Infrared Heaters Height: 4.33" (110 mm) Socket Type: E26x32**

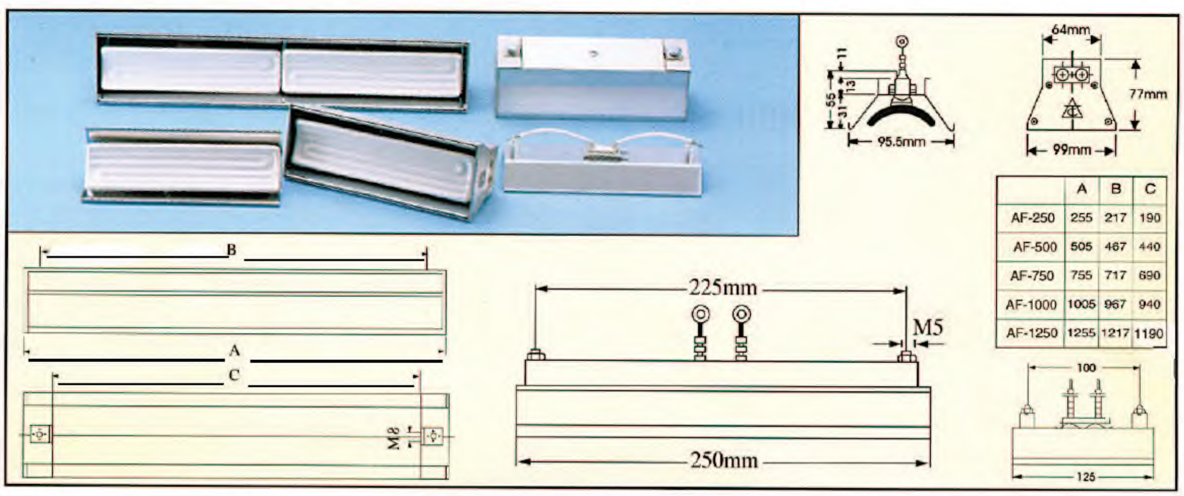
| *Part Number* | *Size* | *Color* | *Voltage* | *Wattage* | *Surface Temp* |
|---|---|---|---|---|---|
| D-1-500-B-2 | 125 | Black | 220/230 | 500 | 600°C |
| D-1-500-B-1 | 125 | Black | 120 | 500 | 600°C |

***Terminal Blocks:***

ITS-1 ITS-2

**ITS-1** 2-Pole Terminal Block (1.56" W x 1.625" L x 1" H); 10 amp maximum per pole @ 932°F (500°C)
**ITS-2** 3-Pole Terminal Block (2.5" W x 1.625" L x 1" H); 10 amp maximum per pole @ 932°F (500°C)

**ITS-26** Screw Base Receptacle for above items (250 V maximum)




| | A | B | C |
|---|---|---|---|
| AF-250 | 255 | 217 | 190 |
| AF-500 | 505 | 467 | 440 |
| AF-750 | 755 | 717 | 690 |
| AF-1000 | 1005 | 967 | 940 |
| AF-1250 | 1255 | 1217 | 1190 |

***Aluminum Housings for the above Ceramic Infrared Heaters:***

**AF-250** Housing for Ceramic Infrared Heaters for A-1 and AWL-1 Series Heaters (1 heater @ 245 mm long)
**AF-500** Housing for Ceramic Infrared Heaters for A-1 and AWL-1 Series Heaters (2 heaters @ 245mm long)
**AF-750** Housing for Ceramic Infrared Heaters for A-1 and AWL-1 Series Heaters (3 heaters @ 245mm long)
**AF-1000** Housing for Ceramic Infrared Heaters for A-1 and AWL-1 Series Heaters (4 heaters @ 245mm long)
**AF-1250** Housing for Ceramic Infrared Heaters for A-1 and AWL-1 Series Heaters (5 heaters @ 245mm long)

# Infrared Heaters

**Quartz Infrared Emitters** are used for industrial heating; our infrared quartz emitters are designed and engineered to your specifications. When you need to apply precise heat radiation with infinite controllability, infrared heating technology is the best option. The four main categories of infrared emitters are shown below. All categories can provide you short-wave or medium-wave along with a variety of options to provide you with optimal solution for your infrared heating technology needs.

## Benefits

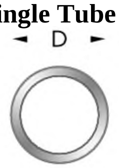
- Decrease power consumption and increase your process speed
- Non-Contact
- Precisely adjust applied heat based on your material properties
- Precision heating with infinite control liability
- Instant on and off response times

| Type | Short Wave | Tungsten-based fast -response medium wave | Carbon– based fast—response Medium - Wave | Medium-Wave |
|---|---|---|---|---|
| **Filament Material** | Tungsten | Tungsten | Carbon Wound | Nickel-Chromium |
| **Filament Temperature** | 1800-2400°C | 1400-1800°C | ~ 1200°C | 800-950°C |
| **Peak Wavelength** | 1.0 –1.4 µm | 1.4 –1.6 µm | ~ 2.0 µm | 2.0 –4.0 µm |
| **Response Time** | 1 sec. | 1-2 sec. | 1.5 - 3 sec | 1 min. + |
| **Guarantee** | 5000 Hrs | 5000 Hrs | 4000 Hrs | 10000 Hrs |

**Quartz Tubes :** Utilizing two styles of 99.9% pure silica quartz tubes– the twin and the single tube. The H-iron design of the twin quartz glass tube provides superior mechanical stability for long infrared emitters-up to a length of 6 meters– and, at the same time, it provides us with a unique opportunity of utilizing both openings as energy sources emitting at the same or different power levels or wavelengths. The single-tube quartz is very common for infrared heaters. A very versatile tube can be manufactured straight or following many complex shapes. The single tube quartz is very common for infrared heaters. A very versatile tube can be manufactured straight or following many complex shapes.

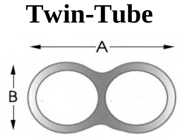
**Standard Quartz Tube Section**

**Single Tube**

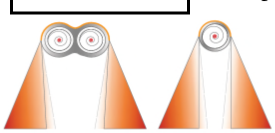



| D (mm) |
|---|
| 8 |
| 10 |
| 12 |
| 15 |
| 19 |

**Twin-Tube**




| A x B (mm) |
|---|
| 18 x 8 |
| 23 x 11 |
| 33 x 15 |



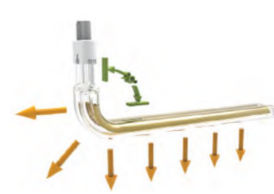
**Reflectors:** To virtually double the emitted energy of an infrared heater, reflecting material may be applied directly to the quartz tube. We use three reflector technologies.

**Gold:** A layer of liquid gold is applied to the surface of the quartz tube. It can reflect >90% of the infrared radiation. It has a working temperature of approximately 1200°F, when properly cooled.

**White Ceramic:** A layer of white ceramic is applied to the surface of the quartz tube. It can reflect about 60-70% of the infrared radiation. It is much more durable and can withstand a working temperature of 1800°F.

**Ruby Red:** This coating is applied 360° around the quartz. Not as much as a reflector, but as a radiation de-intensifier.

With a reflector applied to 180° of the quartz tube, the radiant energy may be more efficiently applied to the material to be heated. At 25mm from the material surface, the energy spread of the lamps is about 12mm from each side of the lamp, with the most intense energy directly below the lamp, that essentially blooms from the center outward.



# Infrared Heaters

## Single Tube Infrared Emitters :

For some applications, an infrared emitters consisting of just one heating filament in a quartz tube may be just the right thing. These emitters are made of high-quality quartz glass. In most cases they are shorter than twin tube infrared emitters and equipped with gold reflectors as required.

### Design Standards:

- Short-Wave: 100 Watts/linear in.
- Fast Response Medium-Wave: 60 Watts/linear in.
- Carbon-based Medium-Wave: 100 Watts/linear in.
- Medium-Wave: 25 Watts/linear in.
- Heated length measured in whole inches
- Voltages: 120VAC, 240VAC, 480VAC
- Available with straight wire leads, quick-disconnects and 90° leads
- Multiple coatings available: Gold, Ceramic, Ruby

## Twin Tube Infrared Emitters :

Twin tube infrared technology offers twice the power in the same package, as compared to single tube. Providing higher radiation density and improved mechanical stability.

### Design Standards:

- Short-Wave: 200 Watts/linear in.
- Fast Response Medium-Wave: 120 Watts/linear in.
- Carbon-based Medium-Wave: 200 Watts/linear in.
- Medium-Wave: 50 Watts/linear in.
- Heated length measured in whole inches
- Voltages: 120VAC, 240VAC, 480VAC
- Available with straight wire leads, quick-disconnects and 90° leads
- Multiple coatings available: Gold, Ceramic, Ruby

## Ring Emitters :

When you need to apply precise heat in configurations up to 360°, ring emitters are your best option. Made from custom shaped pure quartz and gold reflectors, each emitter is designed and manufactured to meet your specifications.

### Design Standards:

- Short-Wave: 100 Watts/linear in.
- Fast Response Medium-Wave: 100 Watts/linear in.
- Carbon-based Medium-Wave: 100 Watts/linear in.
- Medium-Wave: 25 Watts/linear in.
- Center Diameter measured in whole inches
- Voltages: 120VAC, 240VAC, 480VAC
- Available with straight wire leads, quick-disconnects, 90° leads, and full 360° configurations
- Multiple coatings available: Gold, Ceramic, Ruby

## Specialty Infrared Emitters :

Our specialty infrared emitters are engineered for your advanced precision heating needs and can be custom formed to precisely fit your contoured parts. Used for various heating and plastics welding requirements, our specialty emitters are perfect for that completely custom application.

### Design Standards:

- Available in all standard tube materials, diameters, lengths, end terminations, reflective layers, and power densities
- Instantaneous heating rates in shot-wave tungsten filament emitters
- Very fast heating rates in medium-wave emitters
- Available in two optional integrated gold or white reflective layers
- Dimmable operation
- Service life up to 5,000 hours when operating at normal temperatures

# Infrared Heaters

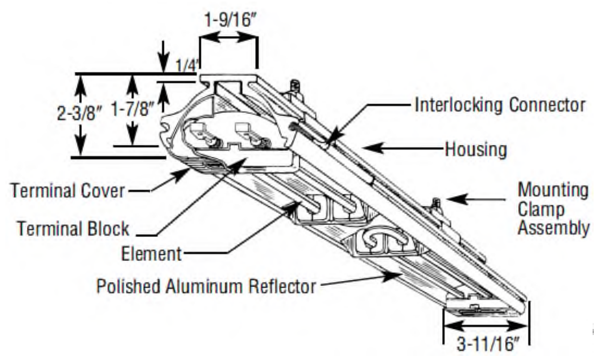
**HR Radiant Heater** assemblies are Incoloy sheathed tubular heaters mounted in an aluminum housing with a reflector to provide a uniform band of radiant heat to the surface. Ideal for applications where high velocity air is not practical, such as conveyorized drying, thermoforming, ink drying tunnels, shrink fitting, thermography, resin curing, and water drying.

- Broad Beam– For industrial use as a surface heating medium.
- Break, splash, shockproof metal sheath heating element– Extruded aluminum housing.
- Absorbed easily by all colors, clear glass, plastics, transparent solids and liquids.
- FAR Infrared– Long visible radiant wave length (2.5/3 microns).
- Typical work range to 500°F, practical maximum to 900°F.

## Design and Insulation:

- Normally used perpendicular to direction of work.
- May be ganged together for continuous heat bank.
- Reflector normally located 12” from work. Distance can be varied due to specific application requirements.
- Snap-on nickel plated protective grill available.
- Each unit has at least two sliding steel clamps for mounting that can be positioned at any point along the length of the housing.

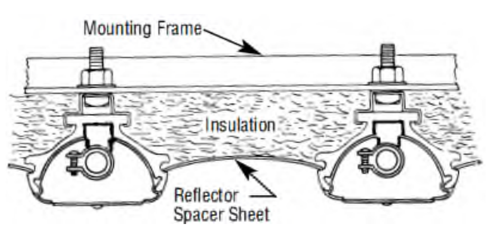
## Single Element




## Double Element

## Single Hair-Pin Element

## NEMA 4/7 Enclosure




## Double Hair-Pin Element

## NEMA 4/7 Dual Enclosure

## Single/Double Hair-Pin:

- Interchangeable elements permit close matching of work dimensions by making it possible to utilize several heated lengths in the same housing.
- Elements can be slid along length of housing to position over area to be heated.

## Ordering Information:

- Watts Volts
- Overall length of reflector housing
- Heated length
- Number of elements (straight or hair pin)
- Thermocouple attached to sheath
- Terminal Housing
- Protective grill

## NEMA 4/7 / Dual:

Radiant heater assemblies feature moisture resistant terminal enclosures. Application possibilities can be expanded to include outdoor comfort heating, locations where wash down of equipment is required or for the protection of terminals from contamination.

# Infrared Heaters

STS

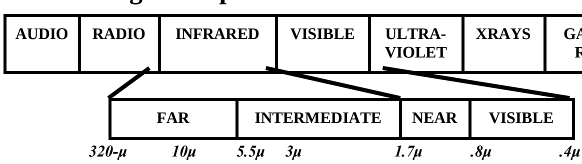
## Process Infrared Heating

As stated and defined in the Thermal System design section, all heat in every process is transferred by conduction, convection or radiation. Often contact of the heat source to the transfer medium or the material being processed is not possible (conduction). The application also might not be practically heated with high-velocity air (convection). In these and many other situations, infrared can be an effective heat transfer method. Infrared is utilized in processes such as:

- Conveyor ovens for drying or curing thin surface films such as paint, lacquer, powder coatings, printing ink or adhesives.
- Heat setting or curing a continuous, fast moving web of uniform thickness material such as textiles.
- Removing surface water or absorbed moisture from materials such as paper, fabrics or chipboard.
- Heating conveyor loads of similar small parts or granular materials.
- Vacuum forming thermoplastic sheet and other processes in the manufacturing of plastics and synthetic materials.
- Localized heating of large parts or assemblies.

Infrared is a form of radiation that falls between visible light and radio waves as shown on the electromagnetic spectrum. Heat is transferred from the source to the work by invisible electromagnetic energy. When the infrared energy reaches the surface to be heated, the molecules vibrate intensely, converting to heat energy. Heat then travels through the product by conduction. Most useful infrared energy for industrial processing results between 1 and 4 microns (μ). A micron is the unit of measurement of infrared wavelengths. ( 1μ = 10cm).

### Electromagnetic Spectrum



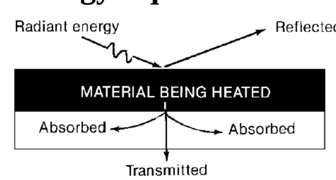

**INFRARED**
- TRAVELS AT SPEED OF LIGHT
- PRODUCES HEAT WHEN ABSORBED
- CAN BE REFLECTED & FOCUSED

The basic infrared theory is that the intermediate heating of the air between the heat source and the product is not required. Because radiant energy travels at the speed of light, heat transfer is very efficient when the characteristics of the material being heated absorbs infrared well. Also, the energy can be directed into specific patterns by the use of reflectors.

**Emissivity factors for Various materials:**

| Solid Materials | Emissivity polished | Emissivity oxydized |
|---|---|---|
| Aluminum | 0.05 | 0.15 |
| Asphalt | | 0.85 |
| Brass | 0.09 | 0.6 |
| Brick/Masonry | | 0.83 |
| Carbon | | 0.96 |
| Concrete | | 0.9 |
| Copper | 0.02 | 0.6 |
| Enamel,white | | 0.92 |
| Flour | | 0.9 |
| Glass | | 0.95 |
| Gold | | 0.02 |
| Gypsum | | 0.9 |
| Ice | | 0.97 |
| Iron,cast | 0.21 | 0.7 |
| Iron,wrought | 0.28 | 0.7 |
| Lead | 0.08 | 0.7 |
| Leather | | 0.95 |
| Limestone | | 0.95 |
| Linoleum | | 0.9 |
| Marble | | 0.9 |
| Meat | | 0.95 |
| Nickel | 0.06 | 0.9 |
| Paper | | 0.85 |
| Paint | | 0.85 |
| Pitch,hard | | 0.95 |
| Plaster | | 0.79 |
| Porcelain | | 0.92 |
| Rubber | | 0.95 |
| Salt,rock | | 0.95 |
| Sand,dry | | 0.76 |
| Silver | 0.03 | 0.8 |
| Stainless Steel | 0.17 | 0.85 |
| Steel | 0.11 | 0.75 |
| Tin | 0.18 | 0.6 |
| Wood | | 0.95 |
| Zinc | 0.03 | 0.5 |
| **Liquid Materials** | | |
| Mercury | | 0.1 |
| Oil, Machine | | 0.82 |
| Water | | 0.96 |

### Energy Equation




How well a material emits or absorbs infrared is it's emissivity factor. The perfect black body is an ideal surface which completely emits or absorbs all radiant energy. The black body's emissivity factor is 1.00. All other surfaces have lower emissivity's, and factors less than 1.00. A practical assumption is that a good emitter is also a good absorber. Hence, a polished aluminum surface with and emissivity of 0.4 would absorb far less radiant energy (everything else being equal) than rooting paper at .91. The energy that isn't absorbed is either reflected or transmitted.

Depending upon a materials' emissivity factor, reflective losses can be high. Where the system design allows, built-in reflectors can re-direct these losses back to the material being heated to where almost all energy is absorbed. Long and medium wavelength infrared emitters such as Incoloy sheath tubulars, quartz, and Black Body Ceramic heaters lose little if any energy by being transmitted through a material. Almost without exception, radiant energy is either absorbed or reflected.

As the distance from the heat source to the material is increased or decreased, the radiation intensity increases or decreases exponentially. In the initial sampling and testing a distance of 12" for a conveyorized process will produce uniform radiant distribution. Specific application considerations may require the distance to be adjusted.

Materials are selective as to the wavelength accepted to absorb infrared energy. PVC will absorb best at 3.5 microns. The wavelength produced by the heat source is dependent upon the source temperature. It is possible then to adjust the source temperature and thus the peak wavelength to match the best spectral absorption rate or wavelength. The formula is:

$$°F = \frac{5215}{\mu} - 459 \qquad °C = \frac{2897}{\mu} - 273$$

If the element temperature is known and the wavelength is desired:

$$\mu = \frac{5215}{459 + °F} \qquad \mu = \frac{2897}{273 + °C}$$

By applying the formula to PVC, based upon 3.5 microns being the desired wavelength, 1025°F (550°C) would be the emitter's surface temperature for the best heat transfer to the process. This principle holds true no matter what the construction of the heat source. An Incoloy tubular heater, the resistance wire of a quartz heater, an FP Flat Panel heater or a Black Body Ceramic Infrared heater operating at 842°F (450°C) would all have the same peak energy wavelength of 4 microns. Other characteristics such as penetration and color sensitivity would also be the same.

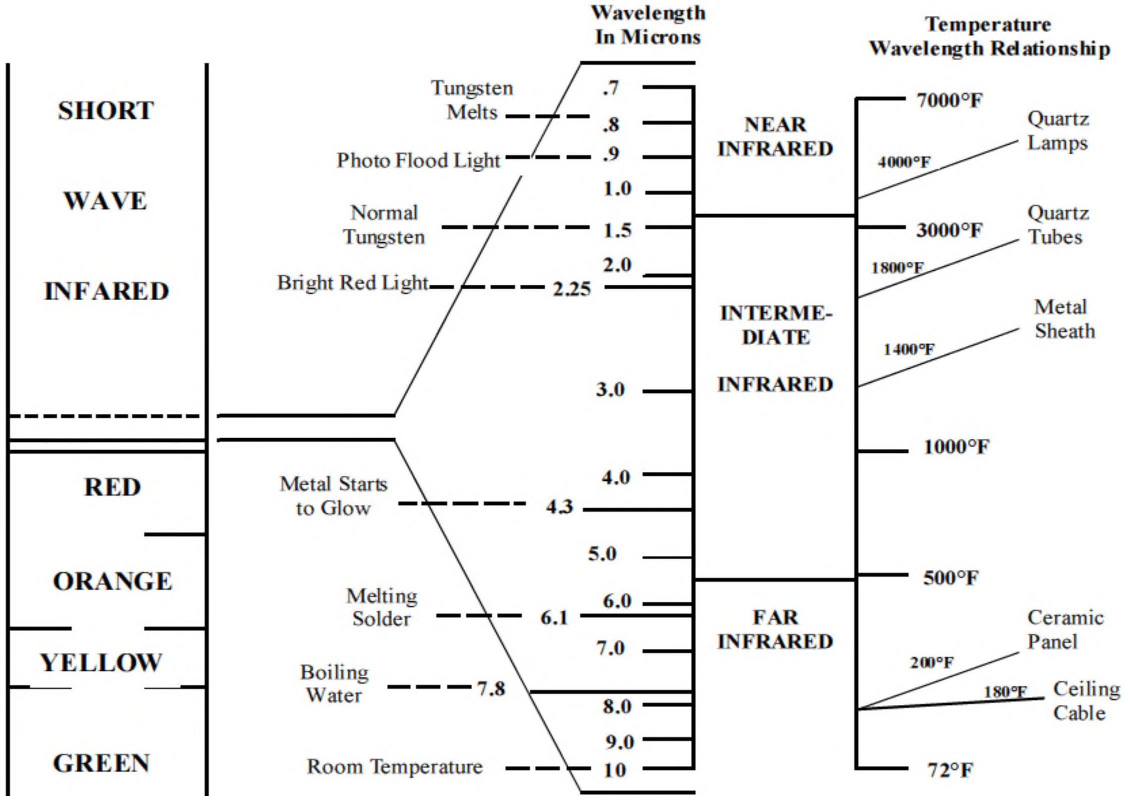
Other common methods of temperature control in infrared processes is by varying the voltage input to the elements or adjusting the amount of on-time versus off-time of the elements. These are open-loop control systems and usually require the constant attention of an operator. A closed loop control system would consist of infrared sensors or thermocouples attached or integral to the heat source, that would monitor the temperature of the process or heater, signal a control which in turn would signal an output device to deliver current (or turn off) the heat source.

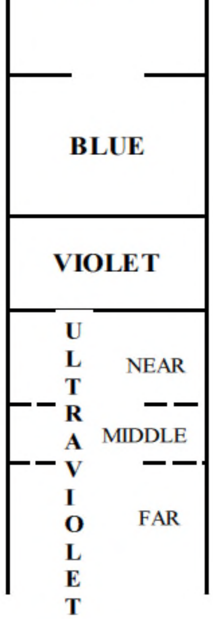
STS offers a number of choices of heating elements for infrared applications. The advantages, limitations and adaptability of each will determine which is most suitable. For instance, the emissivity/conversion ratio of an Incoloy sheath tubular heater is about 55%, a quartz heater is 60%, an FP Flat Panel is about 80% and the Black Body Ceramic is over 90%. This indicates that close to all of the infrared energy produced by the ceramic heater will be absorbed by the process. This type of efficiency may be the most important consideration. But the process may require a heat source with a quick response time. The quartz heater will likely be chosen, or an expensive retraction system may be necessary should a line stoppage occur. The incoloy sheath tubular heater could be the best selection because of its ruggedness and ability to be formed to suit spacing or confinement requirements. A FP Flat Panel heater may be selected because of the wide area coverage.

Although much technical information is available in this and other sources, trial and pilot testing are often necessary to establish if a process is suitable for infrared. The wattage required, watt density, process time cycle, distance from the heat source to the material and how well the material absorbs infrared can perhaps only be determined by this method. Should any uncertainty exist, contact STS.

# Infrared Heaters

## ELECTRIC INFRARED AS PART OF THE ELECTROMAGNETIC SPECTRUM




The sun is the all-energy source, and its energy waves are illustrated technically by this wave-length chart. Man-made infrared energy operates in a narrow portion of the total electromagnetic spectrum. The infrared portion is further broken down into near infrared, intermediate infrared, and far infrared: with near infrared beginning at approximately .8 microns or just beyond the visible portion of the spectrum. Intermediate and far infrared range from approximately 1.5 microns to 7 microns in length.

To best understand the infrared heating method, a comparison with other methods of heat transfer should first be considered. All heat is transferred by one of three methods: conduction, convection, and radiation. Infrared heat falls into the radiation category. Conduction is the transfer of heat by physical contact between the heat source and the object to be heated. Convection utilizes heated air as the transfer medium between the heat source and the object to be heated. Radiant or infrared heat utilizes invisible electromagnetic energy from a heat source to transfer its energy.

Radiant energy is not absorbed by air and does not actually become heat until it is absorbed by an opaque object. While radiant energy does generally show up as heat, this is because it vibrates and rotates the atoms in the absorbing object which results in a rise in the temperature of that object. However, radiant energy may also show up as chemical change in the absorbing object (polymerization) or evaporation of water or solvents. The electromagnetic spectrum is illustrated above. Infrared is that portion of the electromagnetic spectrum bordering on visible light at one end of the spectrum and extending to the microwave region of the radio spectrum –between 1 and 6 microns. (Microns are the unit of measurement for infrared wavelengths.)